G4500/G3500 Portable Power Quality Analyzer

BLACKBOX

Quick Reference Guide

ESPEC

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Introduction - System Overview

Tailored for PQ Analysis at any location, the Portable BLACKBOX has been especially designed to address the needs of **Site Engineers, Electrical Consultants & Utilities**:

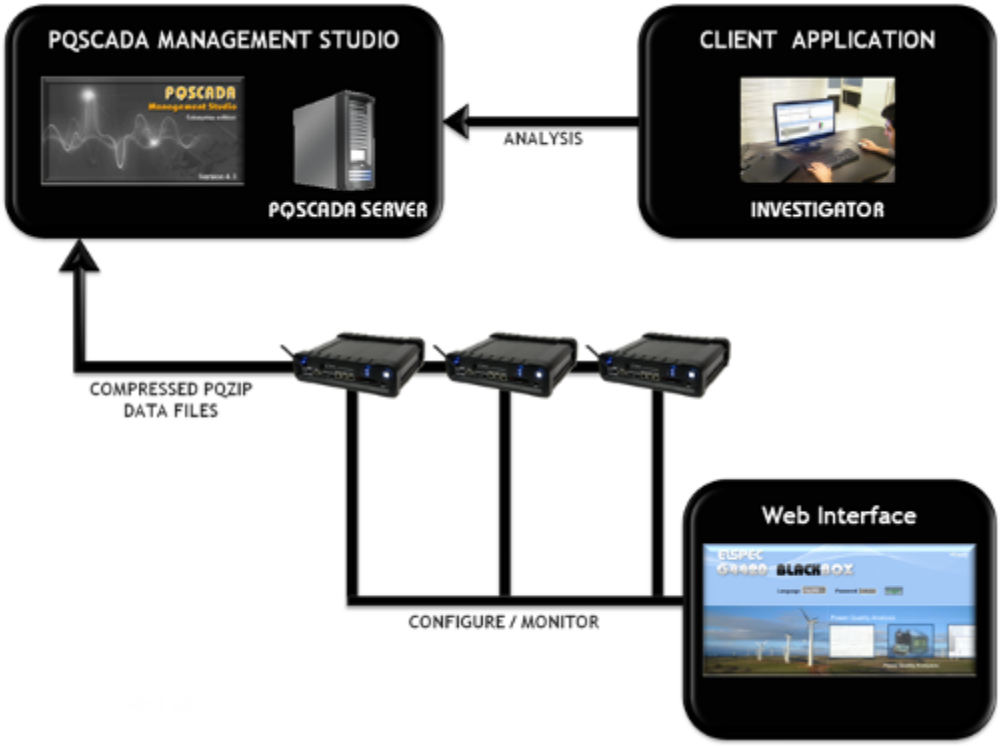
- **No Missed Events**
- **Quick & Simple Setup**
- **Remote Connectivity**
- **Plug & Play**

Empowered by the patented **PQZIP compression** technology, the G4500/G3500 can store up to a thousand times more than other typical file formats. The **PQZIP allows the Portable BLACKBOX** to continuously record & store all electrical waveforms, all the time, for extended periods, with no gaps in the data. Capture everything, Trends, Volts/Amps/Hz, Events, Harmonics, THD, Flicker, Power & Energy to get down to the root cause of all your Power Quality issues. The Portable BLACKBOX fully complies with IEC 61000-4-30 Class A standards for: aggregations, time clock uncertainty, flagging & transient influence quantities.

The advanced **PQSCADA & Investigator Enterprise Analysis** software enables the operator to detect, view, control, analyze & isolate the minutest PQ anomaly for the diagnosis & effective maintenance of equipment. It simplifies troubleshooting & time-synchronized data recorded by any number of BLACKBOX devices, can be compared within a particular site &/or across many sites.

The embedded **Website** serves as the main user-interface with the unit, providing enhanced management, unit configuration & real-time monitoring of all parameters.

The figure below provides a graphical outline of the BLACKBOX Portable System:



EVERYTHING YOU NEED IN A PORTABLE POWER QUALITY SOLUTION & MORE

- 1 X Custom Clamp 3-Flexible Current Probes
- 5 X Voltage Leads (Automatically Detected)
- 2 X DC Voltage Cords (G4500)
- Durable Carrying Case
- Rechargeable Power Supply (2 Hours Standby)
- Wireless Network (G4500)
- PQSCADA / Investigator Software CD
- Mobile Analysis Lab

SEE ALSO:

- Warranty
- Acronyms
- Product Selection Guide

Warranty

Each Elspec product is under warranty to be free from defects in material and workmanship under normal use and service. The warranty period is for one year and commences on the date of shipment. Parts, product repairs, and services are under warranty for 90 days. This warranty extends only to the original buyer or end-user customer and it does not apply to fuses, disposable batteries, or to any product which, in Elspec's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions in the operation or handling of the product. Elspec guarantees that the software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Elspec does not guarantee that the software will be error free and operate without interruption.

Elspec authorized re-sellers shall extend this warranty on new and unused products to end-user customers only, but do not have authority to extend a greater or different warranty on behalf of Elspec. Warranty support is available only if the product is purchased through an Elspec authorized sales outlet or Buyer has paid the applicable international price. Elspec reserves the right to invoice the Buyer for any importation costs for the repair/replacement of parts when the product purchased in one country is submitted for repair in another country.

Elspec's warranty obligation is limited, at Elspec's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to Elspec within the warranty period. For warranty service, contact Elspec directly to obtain a return-authorization. On receipt of the authorization, return the product to Elspec with a description of the problem, including prepaid postage and insurance (FOB destination). Elspec assumes no risk for damage in transit. Following warranty repair, the product will be returned to the Buyer, transportation prepaid (FOB destination). If Elspec determines that the failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation of handling, including overvoltage failures caused by use outside the product's specified rating, or normal wear and tear of mechanical components, Elspec will provide an estimate of repair costs and obtain authorization before commencing work. Following repair, the product will be returned to the Buyer, transportation prepaid, and the Buyer will be billed for the repair and return postage transportation charges (FOB Shipping Point).

This warranty is the Buyer's sole and exclusive remedy and is in lieu of all other warranties, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose. Elspec shall not be liable for any special, indirect, incidental, or consequential damages or losses, including loss of data arising from any cause or theory.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

NOTICE REGARDING PROPRIETARY RIGHTS

This publication contains information proprietary to Elspec. By accepting & using this manual, you agree that the information contained herein will be used solely for the purpose of operating equipment developed & manufactured by Elspec.

SEE ALSO:

- System Overview
- Acronyms
- Product Selection Guide

Acronyms

The following acronyms are being used within this document:

ACRONYM	DEFINITION
PQ	Power Quality
V	Voltage
I	Current
AC	Alternating Current
DC	Direct Current
F	Frequency
V_N	Voltage Neutral
I_N	Current Neutral
A	Ampere
CT	Current Transformer
PF	Power Factor
PT100	Platinum Resistance Thermometers
PU	Per Unit
PT	Potential Transformer (transformation ratio in both magnitude and phase)
CT	Current Transformer
HV	High Voltage
MV	Medium Voltage
LV	Low Voltage
THD	Total Harmonic Distortion
ADC	Analog to Digital Converter
SSL	Secure Sockets Layer
GPS	Global Positioning System
UTC	Coordinated Universal Time

ACRONYM	DEFINITION
LAN	Local Area Network
WAN	Wide Area Network
ADSL	Asymmetric Digital Subscriber Line
CF	Compact Flash
OLP	OLE for Process Control (set of connectivity standards for industrial automation)
OPC	Open Connectivity (formerly OLE for Process Control)
TCP	Transport Control Protocol
FTP	File Transfer Protocol
DHCP	Dynamic Host Configuration Protocol
DNP3	Distributed Network Protocol
PPP	Point to Point Protocol
PAP	Password Authentication Protocol
CHAP	Challenge Handshake Authentication Protocol
UART	Universal Asynchronous Receiver Transmitter
ISP	Internet Service Provider
INIT	Initialization (INIT String used in Modem)
AT	A command string should start with "AT" or "at", except for the commands "A/" and "+++". At or aT are invalid
PST	Value measured over x period that characterizes the likelihood that the voltage fluctuations would result in perceptible light flicker
THD	Total Harmonic Distortion
TDD	Total Demand Distortion
Ampl	Amplitude
FIFO	First In First Out
FFT	Fast Fourier Transform
csv	Comma Separated Values

ACRONYM	DEFINITION
ELSPEC G4500/G3500 BLACKBOX DEVICE & ACCESSORIES	
BB	BLACKBOX
G4500 / G3500	BLACKBOX Portable Power Quality Analyzers
G4150	Mobile Analysis Lab
PQA	Power Quality Analyzer
R/O	Perform **Read Only** Functions Within the BLACKBOX Interface
R/W	Perform **Read & Write** Functions Within the BLACKBOX Interface
RTC	BLACKBOX Internal Real Time Clock
DSP	Digital Signal Processing Module (Located Internally)
PQZIP	Power Quality Data Compression & Archive File Format
PQSCADA	Power Quality Supervisory Control and Data Acquisition
S/N	Serial Number
HW	Hardware
SW	Software
FW	Firmware - BLACKBOX Software

SEE ALSO:

- System Overview
- Warranty
- Product Selection Guide

Product Selection Guide

The product selection guide will assist you in choosing the optimal Portable PQ Analyzer that will suit your needs & requirements. The BLACKBOX device series includes 2 products, namely the G4500 & G3500. They are mainly differentiated by their measurement capabilities, storage capacity, PQ analysis & communication ports.

CAPABILITIES	PRODUCT SERIES	
	G4500	G3500
REAL-TIME MEASUREMENTS		
Voltage Sampling Rate, Maximum Samples/Cycle	1024	512
Voltage/Current - Per Phase, Average, Unbalanced	√	√
Power: Real, Reactive, Apparent, Power Factor, Frequency	√	√
Energy: Bidirectional, Total, Import, Export, Net	√	√
Demand: Block	√	√
Voltage Harmonics (Individual, Even, Odd, Total) Up to-	511TH	255TH
Type of Analog to Digital Converter	16/20[1] Bit	16/20[1] Bit
Measurement During Overloading (From Nominal)	x10	x10
DATA & WAVEFORMS LOGS		
Cycle-By-Cycle PQZIP Recording	√	√
Event Logs	√	√
Continuous Waveform Recording	√	√
Min/Max Logs For Any Parameter	√	√

CAPABILITIES	PRODUCT SERIES	
	G4500	G3500
TIME STAMPS, RESOLUTION (MICROSECONDS)		
With Ethernet Synchronization	50	50
With GPS Synchronization	1	1
STORAGE CAPACITY		
Internal Memory	32 GB 32TB[2]	256 MB 256 GB[2]
POWER QUALITY ANALYSIS		
Transient Detection, Microseconds (50Hz/60Hz)	19.5/16.3µs	39/32.5µs
Sag/Swell Monitoring	√	√
Unbalance Components: Zero, Negative, Positive	√	√
Flicker (IEC 61000-4-15)	√	√
Fast Flickering	√	√
Compliance Testing To EN50160	√	√
EN50160 Timestamps	√	√
Configurable for IEEE519-1992, IEEE159 (SEMI)	√	√
Time Stamps Of Above	√	√
Inter-Harmonics	√	√
POWER SUPPLY		
Power Over Ethernet (PoE- In)[3]	According to 802.3af	
Operating Range	100-260VAC: 50/60Hz 100-300VDC	
Auxiliary AC Supply	48VDC	
Battery Backup	2 Hours	
E-MAIL NOTIFICATIONS		
SMTP Client	√	√

CAPABILITIES	PRODUCT SERIES	
	G4500	G3500
COMMUNICATION		
CONTROL		
Web Server	Comprehensive web server for local & remote real-time monitoring & control	
FTP Server	Standard protocol for main storage memory	
PORTS		
Ethernet Ports	2 LAN & 1 WAN (Integrated Router, NAT & Firewall)	1 LAN
RS-232, RS-485 Ports	1	1
Wi-Fi Communications (802.11g)	1 (With Integrated Antenna)	___
LAN 1		
Communication Protocols	TELNET, OPC, SMTP Client	
Power Over Ethernet (PoE- In)[3]	According to 802.3af	
LAN 2		
Communication Protocols	Modbus TCP, Modbus RTU, OPC, DNP3 & SMTP Client	
Power Over Ethernet (PoE- Out)	1 (Available as Output – 48V / 13 Watt)	

MULTI IO	
DIGITAL INPUTS	
Channels	4
Sampling	800 Hz @ 50Hz (16 spc) 960 Hz @ 60Hz (16 spc)
Range	0 – 220 VDC
Pulse Type	0->1->0, 1->0->1, KYZ
Functionality	Triggers based on events / Energy pulse counting
Isolation Connector	125V
RELAY OUTPUT	
Channels	1 x Change Over
Max Voltage	277 VAC
Max Current	5A / 250VAC 10A / 110VAC 5A / 30VDC
Max Reaction time	10ms
Max Drop-out time	4ms
Output Resistance	50MΩ
[1] EFFECTIVE BITS [2] EQUIVALENT MEMORY NEEDED WITHOUT PQZIP COMPRESSION [3] G4500 UNIT ONLY	DISCLAIMER: OUTLINED CAPABILITIES SUBJECT TO CHANGE WITHOUT PRIOR NOTICE

SEE ALSO:

- System Overview
- Warranty
- Acronyms

Preparation - Safety Precautions

WARNINGS

- REVIEW THE ENTIRE MANUAL BEFORE USING THE INSTRUMENT AND ITS ACCESSORIES
- OBSERVE ALL WARNINGS AND CAUTIONS
- DO NOT OPERATE THE INSTRUMENT AROUND EXPLOSIVE GAS OR VAPOR
- AVOID WORKING ALONE
- BEFORE USE, INSPECT THE INSTRUMENT, LEADS AND ACCESSORIES FOR MECHANICAL DAMAGE, AND REPLACE WHEN DAMAGED
- PAY SPECIAL ATTENTION TO THE INSULATION SURROUNDING THE CONNECTORS AND PLUGS
- REMOVE ALL ACCESSORIES THAT ARE NOT IN USE
- MAKE SURE THE INSTRUMENT IS PROPERLY GROUNDED TO A PROTECTIVE EARTH GROUND
- DO NOT APPLY INPUT VOLTAGES ABOVE THE RATING OF THE INSTRUMENT AS SHOWN ON THE NAME PLATE
- DO NOT INSERT METAL OBJECTS INTO CONNECTORS AND OPENINGS
- NEVER OPEN THE INSTRUMENT'S ENCLOSURE DURING OPERATION; DANGEROUS VOLTAGES ARE PRESENT
- USE THE INSTRUMENT ONLY AS SPECIFIED IN THIS MANUAL, OR THE PROTECTION PROVIDED BY THE INSTRUMENT MAY BE IMPAIRED
- DO NOT EXPOSE THE INSTRUMENT TO EXTREME MOISTURE AND OR RAIN

TO AVOID SHOCK OR FIRE

- VERIFY THAT THE UNIT IS DISCONNECTED FROM THE MAIN POWER SUPPLY
- INSPECT ALL ELECTRICAL AND MECHANICAL CONNECTIONS VISUALLY FOR MECHANICAL DAMAGE AND INTEGRITY OF COMPONENTS AND ACCESSORIES
- INSPECT CURRENT TRANSFORMER WIRING FOR PROPER DIRECTION THROUGH THE CYLINDRICAL APERTURE OF THE CURRENT SAMPLING MODULE
- TEST ALL CONTROL WIRING TO ENSURE SECURE SEATING IN TERMINALS
- BEFORE USE, INSPECT THE INSTRUMENT, LEADS AND ACCESSORIES FOR MECHANICAL DAMAGE, AND REPLACE WHEN DAMAGED
- DO NOT OPERATE THE INSTRUMENT OR ITS ACCESSORIES IF IT BECAME WET FOR ANY REASON

SEE ALSO:

- What You'll Need
- Unpacking Components & Accessories
- G4500 BLACKBOX Unit
- G3500 BLACKBOX Unit

What You'll Need

Familiarize yourself with the G4500 & G3500 BLACKBOX Unit, Components & Accessories. In addition, ensure that you follow the outlined Safety Precautions. You will need the following tools & additional items for the initial installation:

- Wire Strippers
- Phillips Screwdriver
- Flat Head Screwdriver
- Portable BLACKBOX Unit, Components & Accessories
- This User Guide

SEE ALSO:

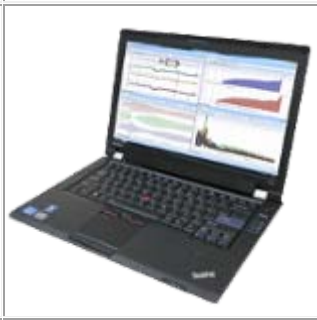
- Safety Precautions
- Unpacking Components & Accessories
- G4500 BLACKBOX Unit
- G3500 BLACKBOX Unit

Unpacking Components & Accessories

The Portable BLACKBOX is shipped from Elspec's factory in a sealed case to protect it from damage during transportation. The small parts are shipped in a sealed bag with the unit.

TO UNPACK THE UNIT & ITS ACCESSORIES

Remove the unit & all of the following components from the casing:

QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
DEVICE, COMPONENTS & ACCESSORIES		
1		**Portable BLACKBOX Device** ▪ G4500 BLACKBOX: SPG-4500-0090 ▪ G3500 BLACKBOX: SPG-3500-0090 **SEE ALSO** ▪ Product Selection Guide
1		**G4150 Mobile Analysis Lab** ▪ SNT-4420-0000[1]
1		**Elspec BLACKBOX Installation & Demonstration Disc [SMX-0408-0103] Containing:** ▪ INVESTIGATOR Software V4 SOF-4001-0000 ▪ PQSCADA Software V4 SOF-4000-0000 ▪ Generic Configuration Utility V1 SOF-4003-0000 ▪ Elspec Search Utility V1 SOF-4004-0000 ▪ Software Support Utilities ▪ G4500/G3500 Quick Reference Guide V1 SMR-3011-0110 ▪ G4500 User Guide V1 SMX-0603-0100 ▪ PQSCADA User Manual V4 SMX-0619-0100 ▪ INVESTIGATOR User Manual SMM-5011-0809 ▪ G4500/G3500 Brochure V1 SMX-0218-0100 ▪ Tutorials V3 SMX-1608-0100

QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
1		**Carrying Trolley Case** (For Mobility) ▪ MEB-2999-0000
1		**5 AC VOLTAGE TEST LEADS & CLIPS:** ▪ Black Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5100 ▪ Red Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5200 ▪ Blue Voltage Cord with Crocodile Clip + Fuse(3M) EAH-4303-5300 ▪ Yellow Voltage Cord with Crocodile Clip + Fuse(3M) EAH-4303-5400 ▪ Green Voltage Cord with Crocodile Clip(3M) EAH-4303-9500
1		**2 DC VOLTAGE TEST LEADS & CLIPS[2]:** ▪ Black Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5100 ▪ Red Voltage Cord with Crocodile Clip + Fuse (3M) EAH-4303-5200
1		**Custom Clamp 3-Flexible Current Probes (Adjustable 30/300/3000A)** ▪ SOA-3003-0270
1		**Custom Clamp 1-Flexible Current Probe (Adjustable 30/300/3000A)** ▪ SOA-3000-0270
1		**Power Cable for Cont. 10A/125V, Straight, 1.8M, Black:** ▪ Europe: EPC-2012-2190 ▪ North America: EPC-7012-2190

QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
1		**48VDC Terminal Block Connector (RoHS Compliant):** ▪ ENT-1002-0190
1		**Temperature Sensor Terminal Block Connector PT100 Type (RoHS Compliant)** ▪ ENT-1002-0191
1		**RS485/422 Communication Terminal Block Connector (RoHS Compliant)** ▪ ENT-1004-0190
1		**Multi IO Terminal Block Connector (RoHS Compliant)** ▪ ENT-2008-0190
1		**Relay Terminal Block Connector (RoHS Compliant)** ▪ ENT-1003-0190
1		**LAN Communication Cord Length: 2M** ▪ TOE-0010-0013
1		**Relay Terminal Block Connector (RoHS Compliant)** ▪ ENT-1002-0190

[1] The mobile analysis lab may be excluded from your Order, if so preferred. The default keyboard for the lab is English. Please ensure that your order has indicated your choice of preference

[2] G4500 unit only

Orders for optional accessories will be delivered as well in a sealed casing. Unpack these parts from their sealed bags:

OPTIONAL ACCESSORIES		
QUANTITY	**ILLUSTRATION**	**DESCRIPTION & PART NUMBER**
As Ordered		**GPS (Global Position System)** (For Mobile Time Synchronization) ▪ SOA-0232-0400
As Ordered		**Multi-Frequency 3.5G Wireless Modem** (For Fast Mobile Communication Access) ▪ SCM-0001-0000
As Ordered		**Protective Weatherproof Pelican Case** (IP64) ▪ SPG-4501-0090
As Ordered		**DWL-P50 Standard POE to Remote Devices** (8 – 12 Volts Adapter) ▪ EBO-5050-0000
As Ordered		**Custom Clamp 3-Flexible Current Probes** ▪ SOA-3003-0270 Current Range 30A / 300A / 3000A AC RMS Operating Temperature -20ºC to + 65ºC Probe Cable Length 610mm (24”) Probe Cable Diameter 194mm (7.5”)

QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
As Ordered		**Custom Clamp 3-Flexible Current Probes** ▪ SOA-3000-0270
		Current Range 30A / 300A / 3000A AC RMS
		Operating Temperature -20ºC to + 65ºC
		Probe Cable Length 610mm (24”)
		Probe Cable Diameter 194mm (7.5”)
As Ordered		**DC Current Custom Clamp** ▪ SOA-0270-1400
		Current Measurement 1,500A DC / 1,000A AC
		Output Signal 1m V/A, 10m V/A
		Operating Temperature - 20°C to + 60°C
		Cable Length 1.4M
As Ordered		**1-6 A Mini Clamp** ▪ SOA-0010-0500
		Measurement Range Up to 6A AC (1A Nominal)
		Output Signal 100 mV/A
		Operating Temperature - 20°C to + 60°C
		Cable Length 1.2M
As Ordered		**100 A Mini Clamp** ▪ SOA-0180-5000
		Measurement Range Up to 100A $_{PK}$ AC
		“Hole” Dimensions 10mm Max
		Operating Temperature - 20°C to + 60°C
		Cable Length 1.2M

QUANTITY	ILLUSTRATION	DESCRIPTION & PART NUMBER
As Ordered		**300 A Flexible Current Clamp** ▪ SOA-9091-3000 Measurement Range 9A ÷ 1050A Output Signal AC: 46mV/1KA Operating Temperature -20ºC to + 60ºC Cable Length 2m
As Ordered		**3000 A Flexible Current Clamp** ▪ SOA-9045-3001 Measurement Range 10Hz ÷ 20kHz Output Signal AC: 46mV/1KA Operating Temperature -20ºC to + 60ºC Cable Length 2m
As Ordered		**Adaptor - Elspec Clamps to BNC (160cm)** ▪ SOA-0270-0000
As Ordered		**Adaptor - Elspec Clamps to Fixed Banana (60cm)** ▪ SOA-0270-0001
As Ordered		**Adaptor - Elspec Clamps to Separated Banana (160cm)** ▪ SOA-0270-0002
As Ordered		**Extension Cable for Elspec Clamps (600cm)** ▪ SOA-4500-0000

SEE ALSO:

- Safety Precautions
- What You'll Need
- G4500 BLACKBOX Unit
- G3500 BLACKBOX Unit

The G4500 BLACKBOX Portable PQ Analyzer

The innovative design of the G4500 BLACKBOX has been uniquely adapted for PQ Analysis at any location. It continuously records all waveform data at a sampling rate for Voltage 1,024 samples per cycle & Current 256 samples per cycle. With an onboard memory of 32GB you can capture everything for more than a year depending on the selected resolution & the individual network condition. It is important to remember that with the built-in PQZIP compression this onboard memory is equivalent to 32TB, enabling you to get to the root cause of all your PQ Anomalies. It features an ultra capacitors' ride-through for up to 25 seconds, an AC/DC power supply, DC/DC converter, can be powered by Power of the Ethernet (PoE In) or by an onboard battery for up to 2 Hours.

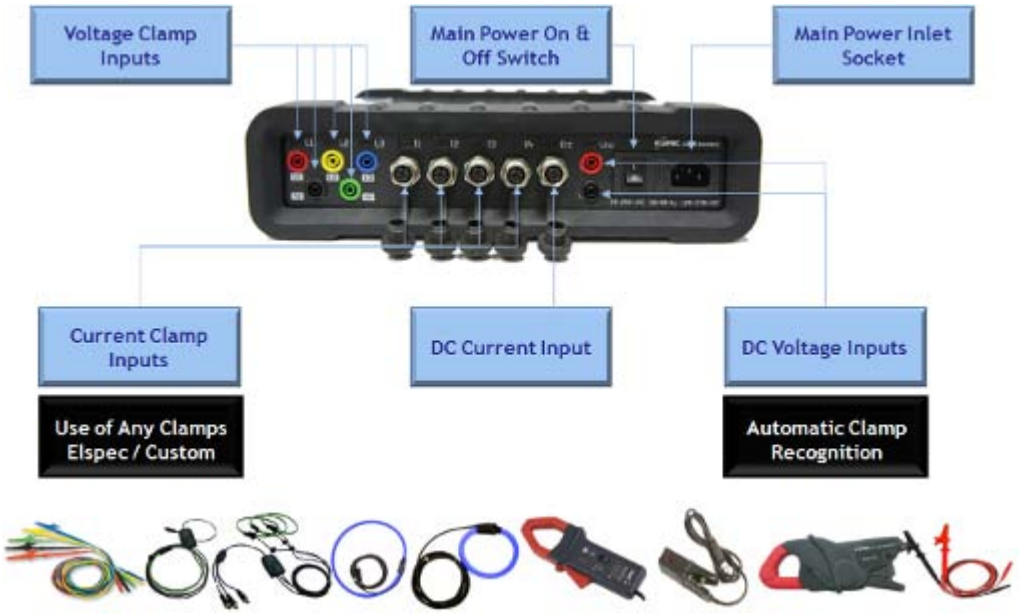
The front panel of the unit mainly facilitates the communication interfaces, the auxiliary power supply & I/O module. It also facilitates one of the important features of the device, namely the remote Wifi antenna & activity indicator.

The rear panel houses another important feature of the G4500, namely the sensor sockets for all the probes. You may use any custom / Elspec probes supplied with the device. Simply plug it in & all the probes will be automatically recognized. The rear panel also houses the On/Off Switch of the Main Power & Inlet Socket.

The illustrations & tables below will serve as a navigational map of all the unit's controls & indicators.

Physical layout of the controls & indicators of the G4500's Front Panel:

Physical layout of the controls & indicators of the G4500's Rear Panel:


Voltage Clamp Inputs
Main Power On & Off Switch
Main Power Inlet Socket
Current Clamp Inputs
DC Current Input
DC Voltage Inputs
Use of Any Clamps Elspec / Custom
Automatic Clamp Recognition

INDICATOR / CONTROL	DETAILED USAGE REFERENCE
FRONT PANEL	
Wi-Fi Activity & Antenna	Wireless Single PC Connection
Auxiliary Power Supply	Unit Powering
Digital Inputs	IO Ports
Serial Ports	Establish 1ST Time Connection
USB Network Communication Port	Establish 1ST Time Connection
Battery Indicator	Battery Replacements
Power Indicator	Unit Powering
Main Power Supply On/Off Switch	Unit Powering
LAN Ports	Establish 1ST Time Connection
WAN Port	Establish 1ST Time Connection
External Temperature Port	IO Ports
Reset Button	Instrument Settings
Relay Port	IO Ports

REAR PANEL	
Voltage Clamp Inputs	**Connect Voltage Probes**
Current Clamp Inputs	**Connect Current Clamps**
DC Current Input	**Connect Current Clamp**
DC Voltage Inputs	**Connect Voltage Probes**
Main Power On/Off Switch	**Unit Powering**
Main Power Inlet Socket	**Unit Powering**

SEE ALSO:

- Safety Precautions
- What You'll Need
- Unpacking Components & Accessories
- G3500 BLACKBOX Unit

The G3500 BLACKBOX Portable PQ Analyzer

The innovative design of the G3500 BLACKBOX has been uniquely adapted for PQ Analysis at any location. It continuously records all waveform data at a sampling rate for Voltage 512 samples per cycle & Current 512 samples per cycle. With an onboard memory of 256MB you can capture everything for more than a year depending on the selected resolution & the individual network condition. It is important to remember that with the built-in PQZIP compression this onboard memory is equivalent to 256GBG, enabling you to get to the root cause of all your PQ Anomalies. It features an ultra capacitors' ride-through for up to 25 seconds, an AC/DC power supply, DC/DC converter, can be powered by Power of the Ethernet (PoE In) or by an onboard battery for up to 2 Hours.

The front panel of the unit mainly facilitates the communication interfaces, the auxiliary power supply & I/O module.

The rear panel houses another important feature of the G3500, namely the sensor sockets for all the probes. You may use any custom / Elspec probes supplied with the device. Simply plug it in & all the probes will be automatically recognized. The rear panel also houses the On/Off Switch of the Main Power & Inlet Socket.

The illustrations & tables below will serve as a navigational map of all the unit's controls & indicators.

Physical layout of the controls & indicators of the G3500's Front Panel:

Physical layout of the controls & indicators of the G3500's Rear Panel:

Main Power Inlet Socket
Main Power On/Off Switch
Voltage Clamp Inputs
Current Clamp Inputs
Use of Any Clamps Elspec / Custom
Automatic Clamp Recognition

INDICATOR / CONTROL	DETAILED USAGE REFERENCE
FRONT PANEL	
Auxiliary Power Supply	**Unit Powering**
Digital Input	**IO Ports**
Serial Ports	**Establish 1ST Time Connection**
Battery Supply	**Battery Replacements**
Power Indicator	**Unit Powering**
LAN Ethernet Port	**Establish 1ST Time Connection**
Reset Button	**Instrument Settings**
Relay Port	**IO Ports**
REAR PANEL	
Voltage Clamp Inputs	**Connect Voltage Probes**
Current Clamp Inputs	**Connect Current Clamps**
Main Power On/Off Switch	**Unit Powering**
Main Power Inlet Socket	**Unit Powering**

SEE ALSO:

- Safety Precautions
- What You'll Need
- Unpacking Components & Accessories
- G4500 BLACKBOX Unit

Installation

This section contains the installation & setup procedure for the Portable BLACKBOX that is quick & simple to follow. After you have installed your BLACKBOX device, you can:

- Monitor the Quality of your Electrical Power,
- Monitor PQ Parameters according to EN50160, IEC61000-4-30 & Customized Standards
- Store a 1000 Times More than other typical file formats with PQZIP

QUICK & SIMPLE INSTALLATION

The simple **Step-x-Step** procedure includes:

- Unit Powering
- Establish 1st Time Connection
- Plug in & Play the Voltage & Current Probes
- Unit Access
- Quick Unit Configuration
- Verify Measurement Readings
- Enable PQZIP Recording

WARNING

Before you start ensure that the panel is de-energized & that you take the necessary Safety Precautions!

Unit Powering

You may either power up either G4500 / G3500 Portable BLACKBOX by using the main AC Power Supply / the Auxiliary Power Supply / Battery Power Supply:

CONNECT BY USING THE AC POWER SUPPLY:

WARNING

85-260V AC ± 10%, 50/60Hz **OR** **120-370V DC**	▪ **2A/250V Fuse Holder** ▪ **Use only suitable fuse replacement!** ▪ **Make sure the Instrument is properly grounded through the power cord to protective earth ground**
35-55V DC Watt Maximum	

- On the Rear Panel connect the female end of the Power Cable to the Main Power Supply inlet socket of the unit:

- Connect the male plug end of the Power Cable to the electrical supply outlet

- On the Front Panel turn on the Main Power Supply Switch to the **ON** position:

- On the Rear Panel turn on the Main Power Switch to the **ON** position:

- Verify that the unit is running on AC Power by using the status indicator lights:

Flashing Blue	**Main Power Applied, Battery Charging**
Solid Blue	**Main Power Applied, Battery Fully Charged**

CONNECT BY USING THE AUXILIARY POWER SUPPLY:

WARNING	
48V DC **(35- 55V)**	▪ **No replaceable fuse protection!** ▪ **Do not allow significant overvoltage!**
35 Watt Maximum	▪ **The 48VDC power supply should be isolated from the mains by double or reinforced insulation**

- On the Front Panel connect the female end of the Auxiliary Cable to the Auxiliary Port of the unit to the corresponding **+/-** connection:

- On the Front Panel turn on the Main Power Supply Switch to the **ON** position:

- Verify that the unit is running on Auxiliary Power by using the status indicator lights:

Flashing Blue	**Main Auxiliary Power Applied, Battery Charging**
Solid Blue	**Main Auxiliary Power Applied, Battery Fully Charged**

POWER THE UNIT BY USING THE BATTERY SUPPLY:

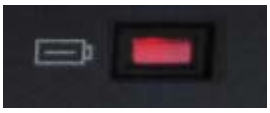
The BLACKBOX Portable contains an internal, uninterrupted power supply module providing a short period of self-powered measurements sessions &/or power supply interruptions ride-through. The Internal UPS system contains a lithium battery for a up to 2 hours of fully-functioning operation & a super capacitors module allowing an additional 25 seconds of short interruptions ride-through even in the case of the main battery being fully discharged. The battery & super capacitors modules require no maintenance and are designed for a long service life. However, if the battery shows a significant decrease in performance, it should be replaced with a factory original. Consult with your local Elspec agency for replacement battery ordering information & see Battery Replacement, in order to change your Battery.

Procedure for using the Battery Supply:

- On the Front Panel turn on the Main Power Supply Switch to the **ON** position:

- Verify that the unit is running on Battery Power by using the status indicator lights:

Red	**Powered by the Internal Battery**



- Go to the next step - Unit Wiring

SEE ALSO:

- About Quick Installation
- About Portable Wiring
- Plug and Play Voltage & Current Probes
- Grounding
- Establish 1st Time Connection
- Unit Access
- About Quick Configuration
- Verify Measurement Readings
- Enable PQZIP Recording

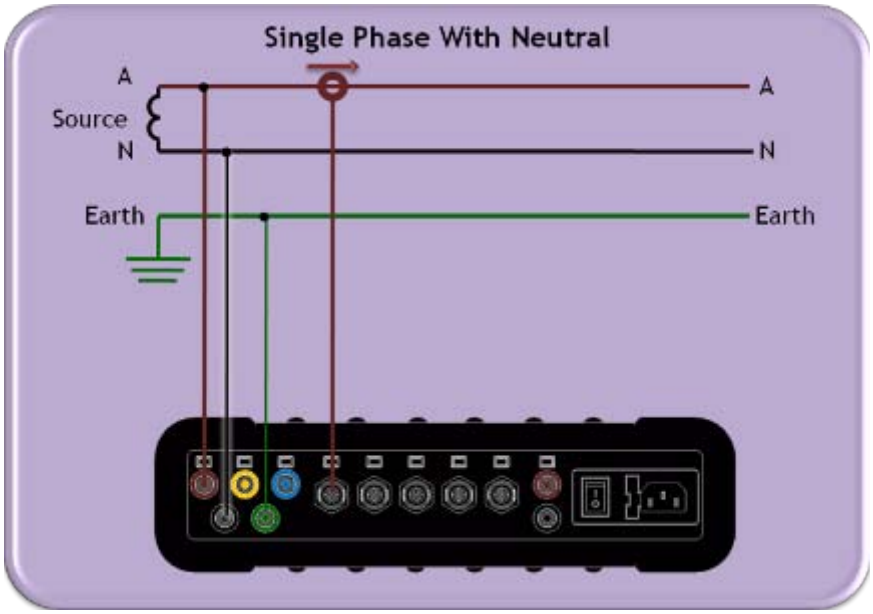
G4500 & G3500 Unit Wiring

An essential part of the Wiring Procedure is the Power Configuration, which is configured in the Web Interface. Prior to proceeding with Plugging in & Playing your Voltage & Current Probes, familiarize yourself with the types of Power Topology the BLACKBOX Portable supports & Grounding of the unit.

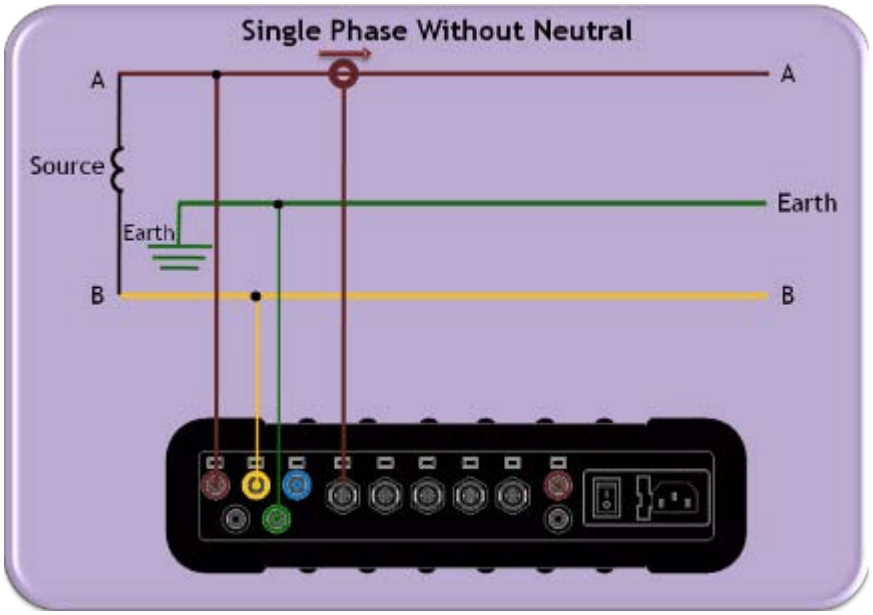
BLACKBOX PORTABLE POWER TOPOLOGY SUPPORTS

The BLACKBOX is designed to serve in virtually any power topology configuration. The diagrams below outline the types of topologies with their applicable Configuration in Elspec's Web Interface. It includes the Portable BLACKBOX configurations followed by the actual power configuration in brackets:

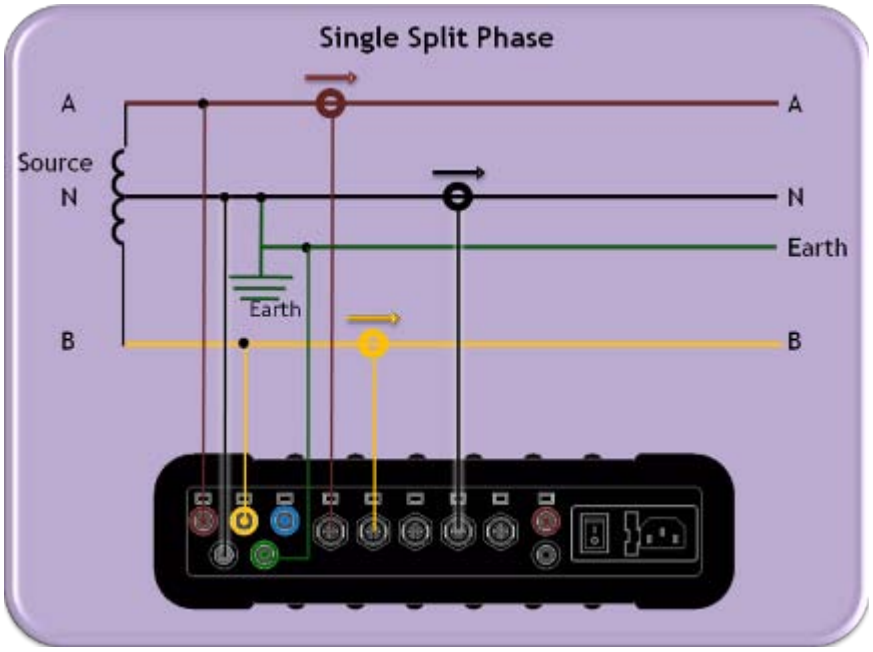
SINGLE LN [SINGLE PHASE WITH NEUTRAL]:



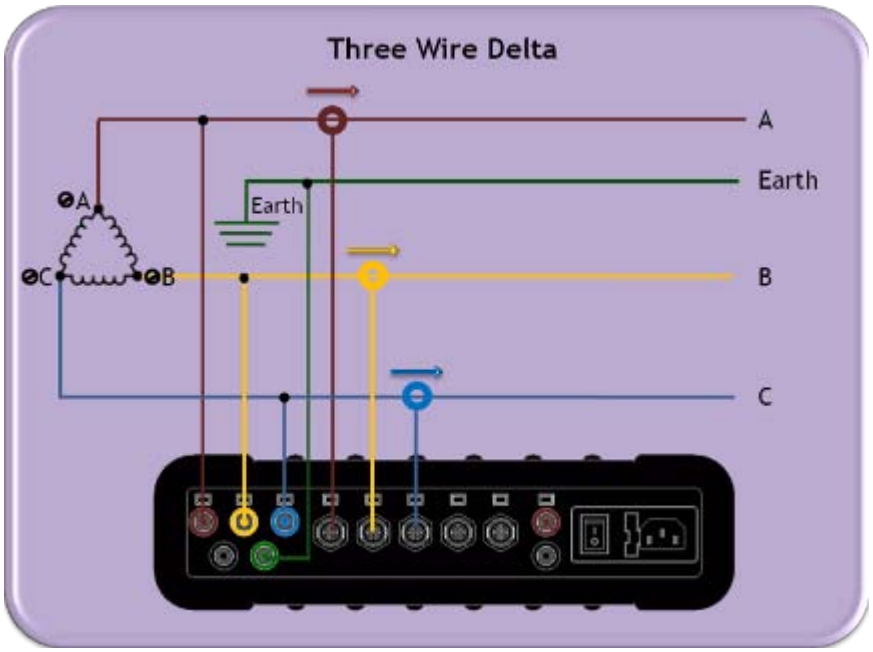
SINGLE LL [SINGLE PHASE WITHOUT NEUTRAL]:



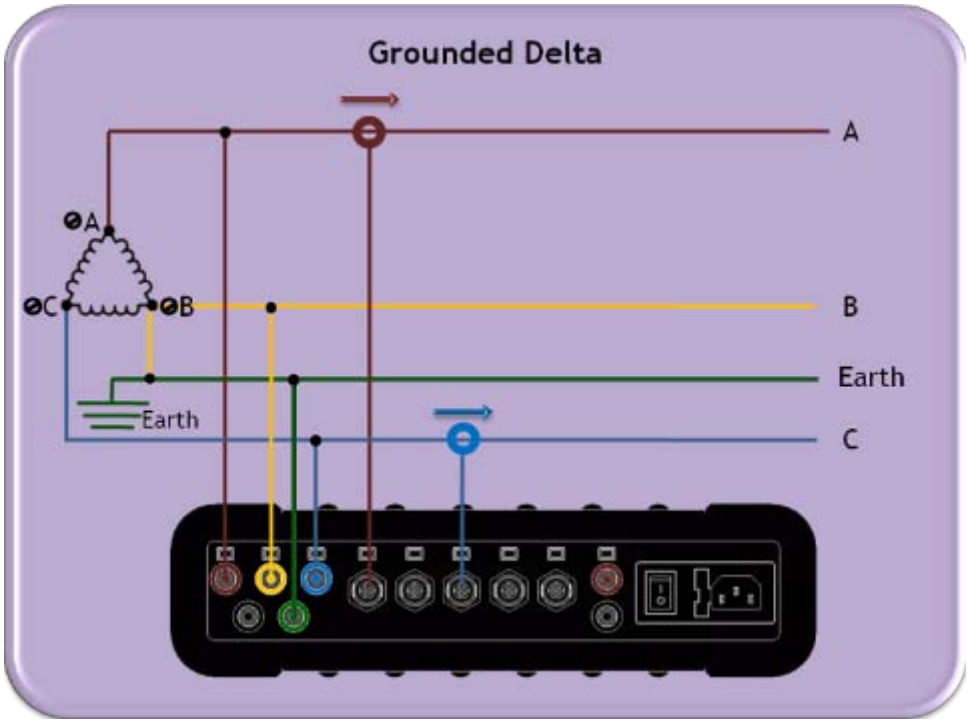
2PHASE TR [SINGLE SPLIT PHASE]:



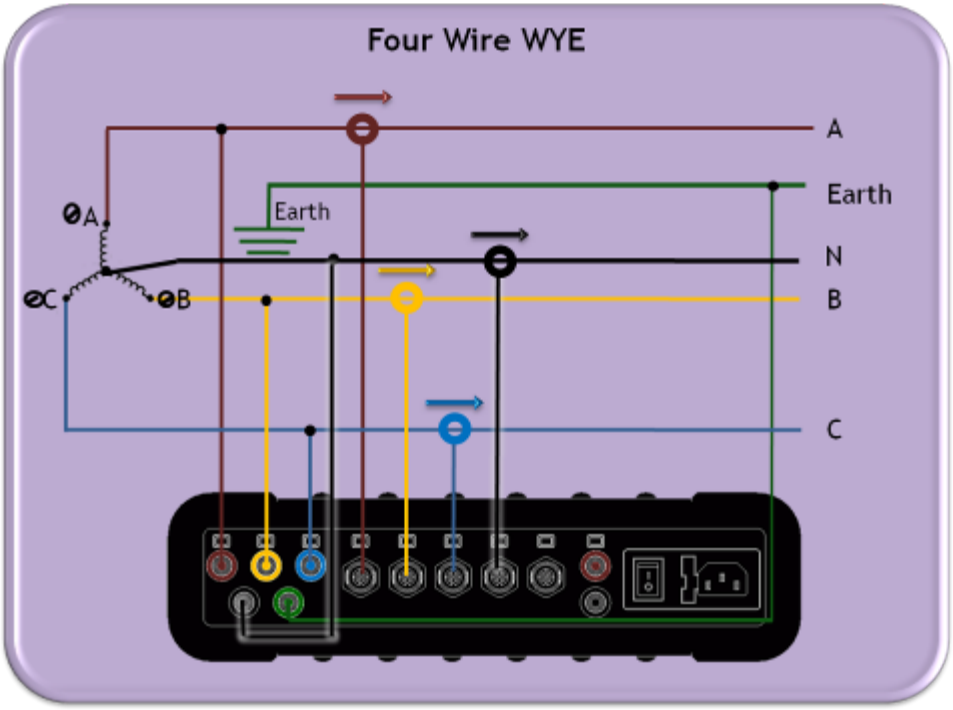
DELTA 3 WIRES [THREE WIRE DELTA]:



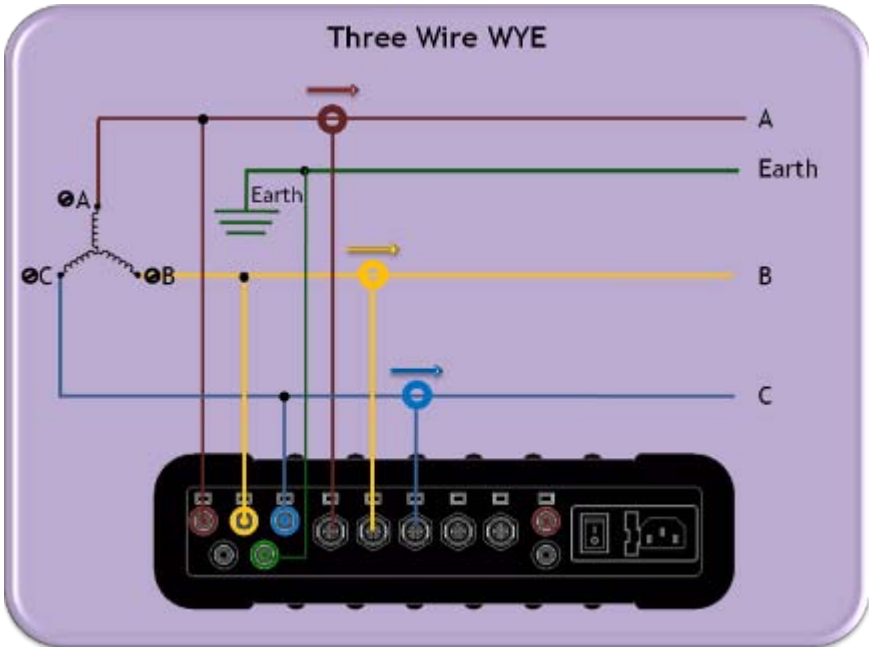
DELTA 3 WIRES [GROUNDED DELTA]:



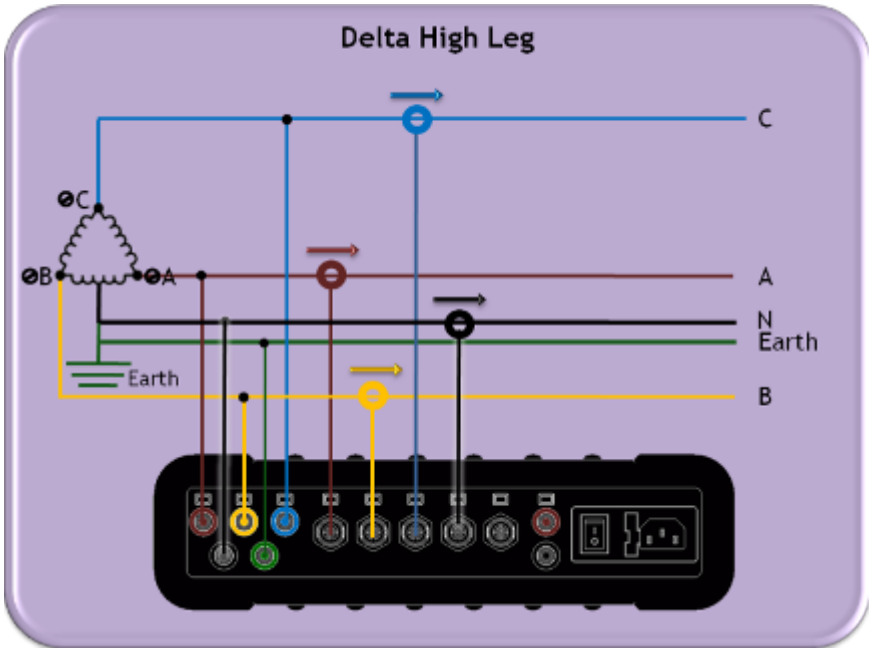
WYE 4 WIRES [FOUR WIRE WYE]:



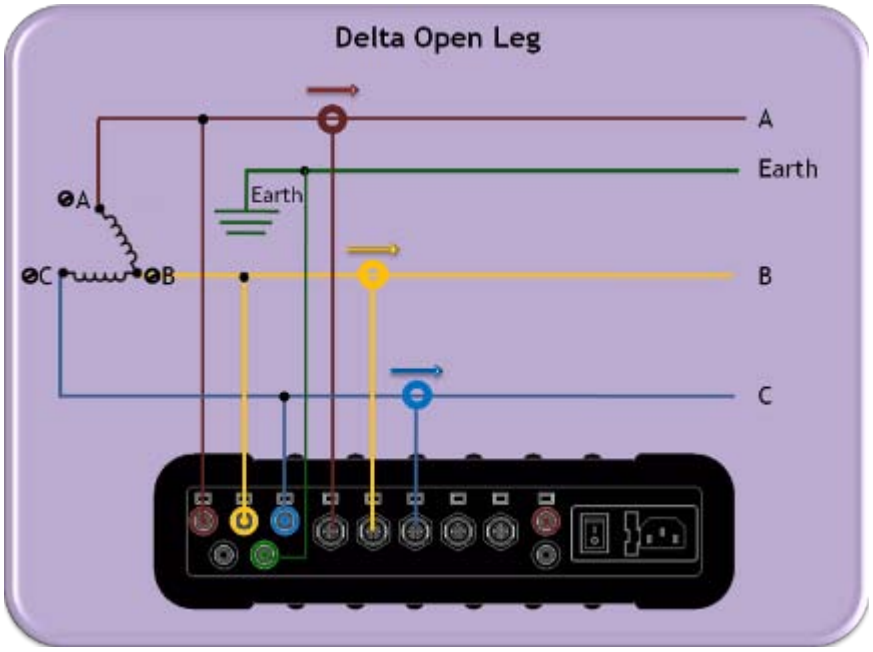
WYE 4 WIRES [THREE WIRE WYE]:



DELTA 3 WIRES [DELTA HIGH LEG]:



DELTA 3 WIRES [DELTA OPEN LEG]:



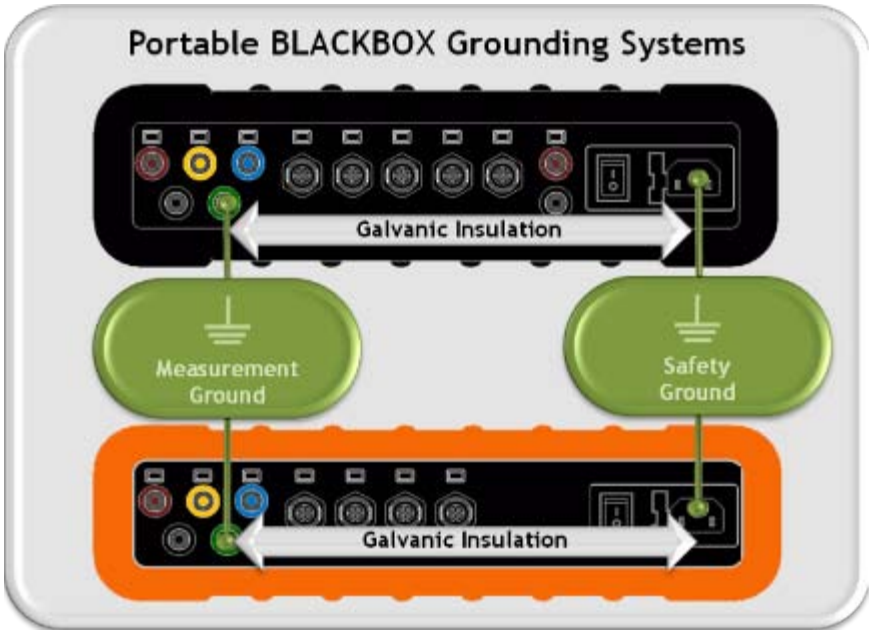
SEE ALSO:

- About Quick Installation
- Unit Powering
- Plug and Play Voltage & Current Probes
- Grounding
- Establish 1st Time Connection
- Unit Access
- About Quick Configuration
- Verify Measurement Readings
- Enable PQZIP Recording

Grounding

The Portable BLACKBOX contains two independent ground systems, one for measurements & one for safety. Internally the ground systems are isolated in order to avoid ground loops. Externally they may be safely connected to the same or different ground systems.

- **Point 1 - Measurement Ground:** The reference point for measured electrical system,
- **Point 2 - Safety Ground:** The reference for the line cord ground. Enclosure for connectors related metal parts:



NOTE NOTE NOTE

- **Maximum permitted voltage between Measurement & Safety Grounds is 2kV DC or 1.5kV AC.**
- **The Ground input is the reference for all channels therefore it is essential to connect it properly.**

- Proceed to the next step - Plug and Play Voltage & Current Probes

SEE ALSO:

- About Quick Installation
- Unit Powering
- About Portable Wiring
- Plug and Play Voltage & Current Probes
- Establish 1st Time Connection
- Unit Access
- About Quick Configuration
- Verify Measurement Readings
- Enable PQZIP Recording

Plug & Play - Voltage & Current Probes

The Portable BLACKBOX houses 5 x AC Voltage, 4 x AC Current & 1 x AC/DC Current Sockets. In addition the G4500 houses 2 x VDC Sockets**.** It is a simple matter of plugging in the Voltage & Current Probes into the device & it will be automatically recognized.

The BLACKBOX is designed to serve in virtually any power topology configuration, see Circuit Topologies in order to interface your device with your circuit topology.

PLUG IN THE AC VOLTAGE PROBES:

- Plug in the Voltage Probes into the applicable sockets located on the Rear Panel. Plug the phase & ground cables in as:
  - L1 to L1 (Red to Red)
  - L2 to L2 (Yellow to Yellow)
  - L3 to L3 (Blue to Blue)
  - Ground to Ground (Green to Green)
  - Earth to Earth (Black to Black)

- Attached **Crocodile Ends of the Probes** to the Measured Power Source:

- The LED light will illuminate confirming a solid connection & the Voltage Levels are above 10% of the nominal value:

SPECIFICATION	G4500	G3500
Maximum Voltage Input	1KV	1KV
Nominal Voltage Range	110 to 690V	110 to 690V
Maximum Peak Measurement Voltage	8KV	8KV
Input Impedance	3MΩ	3MΩ
Bandwidth	25kHz	12.5kHz
Nominal Frequency	42.5Hz to 69Hz	42.5Hz to 69Hz

PLUG IN THE CURRENT PROBES:

You may use any clamp (either Elspec / Custom clamps). The clamps convert current to low voltage.

- Plug in the Current Probes into the applicable sockets located on the Rear Panel (Pay attention to the phase connections, as the channels are calibrated according to the clamps - I1 for I1; I2 for I2; I3 for I3; I4 for I4 & IDC for the DC Clamp):

- Connect the measurement end to the measured power source:

- The LED light will illuminate confirming a solid connection:

SPECIFICATION	G4500	G3500
Number of Inputs	4 (3 Phases & Neutral) + DC/Ground	4 (3 Phases & Neutral)
Maximum Peak Measurement	I1 to I4: 10 V_{Pk} I5: 3 V_{Pk} From Clamp	I1 to I4: 10 V_{Pk} From Clamp
Type	Clamp On Current Transformer With mV Output	Clamp On Current Transformer With mV Output
Range	I1 to I4: 0 to 10 V_{Pk} I5: 0 to 3 V_{Pk} From Clamp	I1 to I4: 0 to 10 V_{Pk} From Clamp
Burden	0.05VA (Typical) @ 5 IRMS	0.05VA (Typical) @ 5 IRMS
Bandwidth	25kHz (Typical) @ 5 IRMS	12.5kHz

PLUG IN THE G4500'S VDC PROBES:

The G4500 facilitates Auxiliary **DC(+)** & **DC(-)** voltage & current inputs & provides an independent input to the main AC/DC channel DC voltage readings. The measurement range ranges from -1000VDC to +1000VDC at a rate of once every second. This is mainly suitable for a voltage converter DC link side reading while the main voltage channels are on the grid side.

- Plug in the DC Probes into the applicable sockets located on the Rear Panel - **Red(+) & Black(-):**

- Connect the measurement end to the measured power source
- No configuration is necessary for the automatically recognized DC V/I Probes, you may however choose to **Enable / Disable** the recording at your own choosing. See Capture DC.

SPECIFICATION	
Maximum Voltage Input	1KV
Galvanic Insulation from Main AC / DC Channels	3KV
Recording Resolution	200 µs

- Go to the next step - Establishing a 1st Time Connection

SEE ALSO:

- About Quick Installation
- Unit Powering
- About Portable Wiring
- Grounding
- Establish 1st Time Connection
- Unit Access
- About Quick Configuration
- Verify Measurement Readings
- Enable PQZIP Recording

Establish 1st Time Connection

A quick & simple connection can be established to your Network or G4150 or your local PC by using the Portable BLACKBOX's fast Ethernet ports (10/100 MB) / Wireless Link.

G4500 Portable BLACKBOX:

- **Wi-Fi:** Convenient Wireless Connection
- **WAN:** Broadband router (ADSL/ Cable / Cellular) for Internet accessibility - See Communication
- **LAN1:** G4150/ DHCP/ PC / Laptop Connection - See Communication
- **LAN2/LCD:** Direct connection to LAN Network of Computers - See Communication
- **Serial Interface Ports:** See Communication

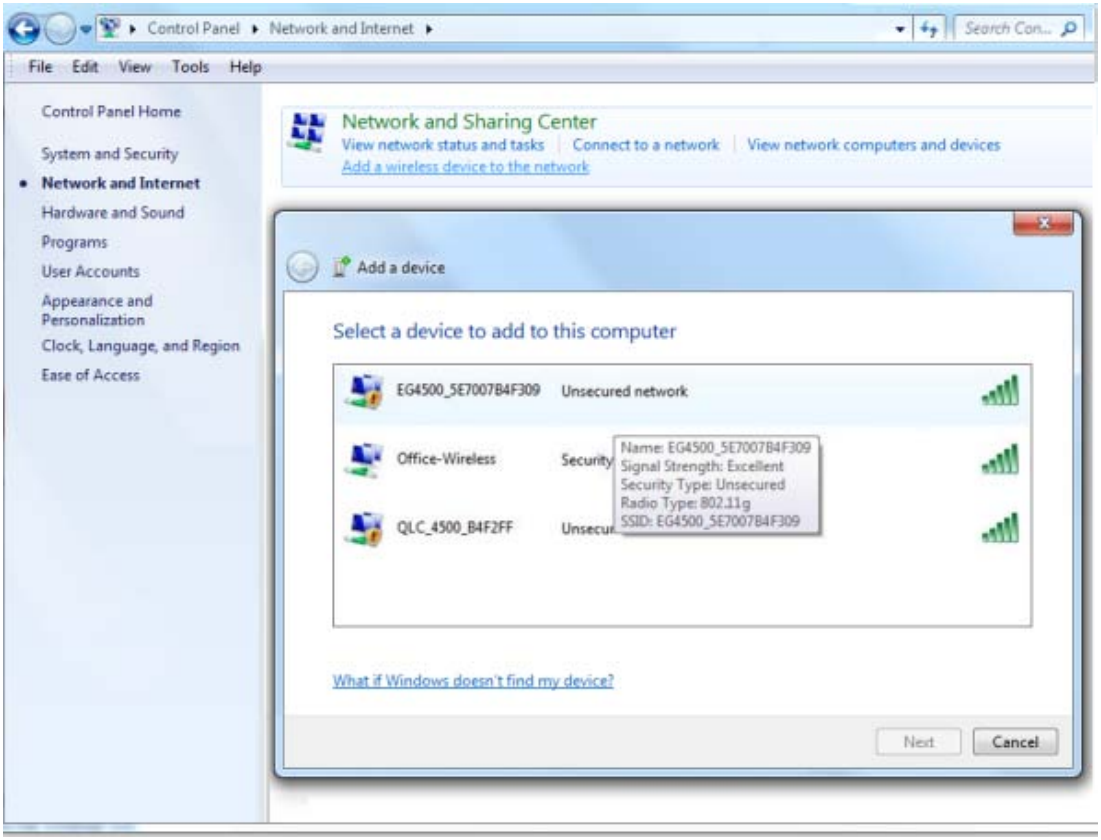
G3500 Portable BLACKBOX:

- **LAN/LCD:** Main connection port (G4150/ DHCP / PC/ Laptop/ LAN Network of Computers)
- **Serial Interface Ports:** See Communication

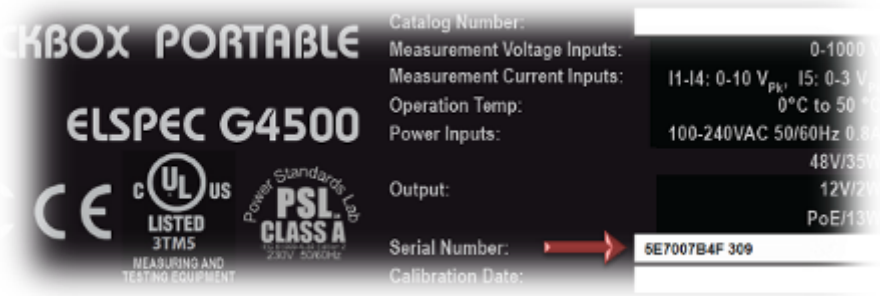
G4500 WI-FI CONNECTION

Equipped with a built-in IEEE 802.11 g/b router configured as an industry standard access point, the G4500 provides convenient & instant connectivity to your G4150, including to a PC/Laptop that is Wi-Fi enabled.

- After you have switched on your G4500 Portable PQ Analyzer, search for the device by its unique **S/N**:



- The **S/N** is located on the G4500's name plate:

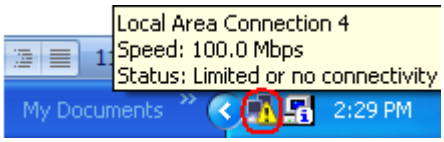


- The Wi-Fi Activity Indicator will confirm connection (Flashing / Solid Blue):

G3500 LAN/LCD CONNECTION

- After you have switched on your G3500 Portable PQ Analyzer, connect the LAN Communication Cord to the port marked LAN/LCD on the units' Front Panel:

- The green link-LED of the LAN1 connector begins to flash as Windows begins communicating with the unit
- Wait for about 2 minutes as the Windows operating system reverts to the default "No Server" IP configuration
- When this is completed, the "Local Area Connection Status" icon in the "Quick Start" tray will change to "Limited or no connectivity":

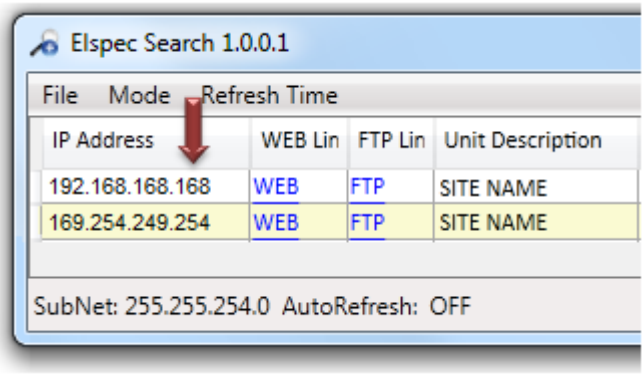


SEE ALSO:

- About Quick Installation
- Unit Powering
- About Portable Wiring
- Grounding
- Plug and Play Voltage & Current Probes
- Unit Access
- About Quick Configuration
- Verify Measurement Readings
- Enable PQZIP Recording

G4500 / G3500 Unit Access

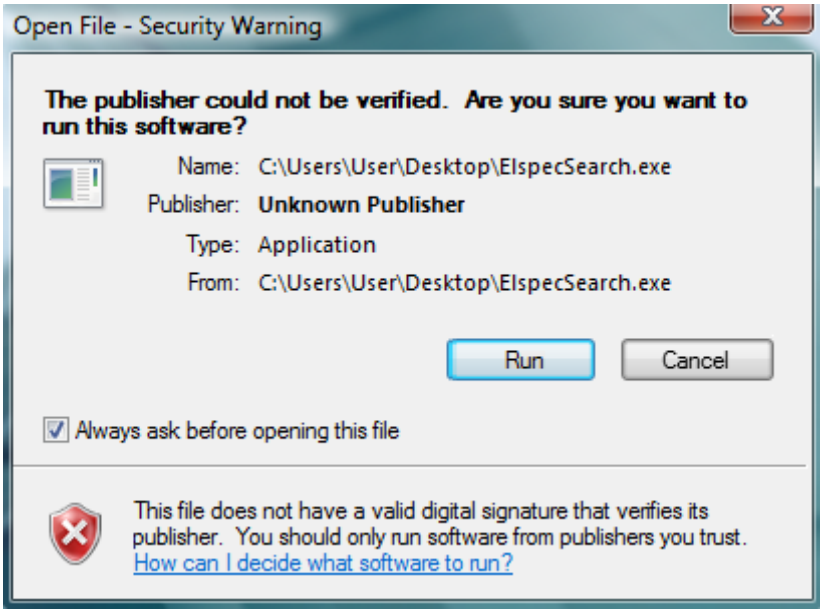
Once you have Connected the Device for the 1st Time, you may access your Portable BLACKBOX Unit by simply clicking the WEB Hyperlink button in your Elspec's Search Utility. Alternatively you can simply access the device directly via the Internet Explorer by inserting the Device's IP address directly (address is also indicated in Elspec's Search Utility).



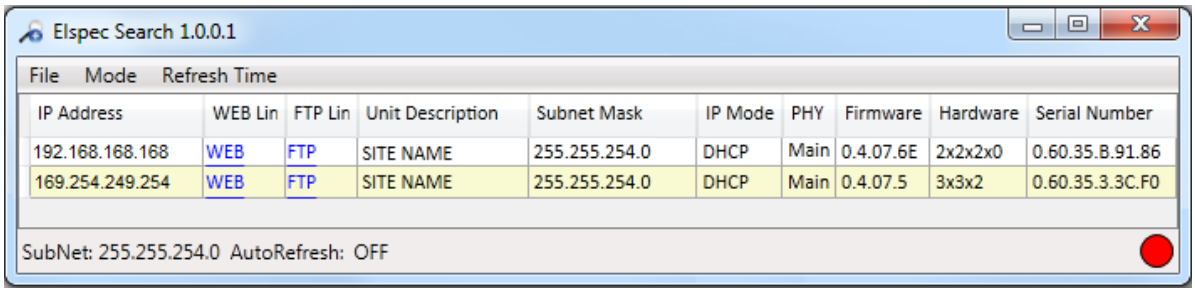
ACCESS ELSPEC'S SEARCH UTILITY:

- After you have Copied the Utility on your Desktop, access it by clicking on the Elspec's Search Icon:

- Initially, the program may trigger a verification warning similar to the one below. You may proceed by clicking **Run**:


Open File - Security Warning
The publisher could not be verified. Are you sure you want to run this software?
Name: C:\Users\User\Desktop\ElspecSearch.exe
Publisher: Unknown Publisher
Type: Application
From: C:\Users\User\Desktop\ElspecSearch.exe
Run
Cancel
Always ask before opening this file
This file does not have a valid digital signature that verifies its publisher. You should only run software from publishers you trust.
How can I decide what software to run?

- A scan procedure is initiated; the Elspec Search utility appears as a grid displaying all BLACKBOX devices found on the intranet network:


Elspec Search 1.0.0.1
File Mode Refresh Time
IP Address WEB Lin FTP Lin Unit Description Subnet Mask IP Mode PHY Firmware Hardware Serial Number
192.168.168.168 WEB FTP SITE NAME 255.255.254.0 DHCP Main 0.4.07.6E 2x2x2x0 0.60.35.B.91.86
169.254.249.254 WEB FTP SITE NAME 255.255.254.0 DHCP Main 0.4.07.5 3x3x2 0.60.35.3.3C.F0
SubNet: 255.255.254.0 AutoRefresh: OFF

ACCESS INSTRUMENT VIA THE WEB HYPERLINK (RECOMMENDED):

- Select the **Web** link for your device, Elspec's Web Interface will now open:

- In order to view the different languages in the Web Interface, you will need to upload the language feature from Elspec's Website when installing your new Firmware. Once uploaded, simply select the applicable interface language from the drop-down list:

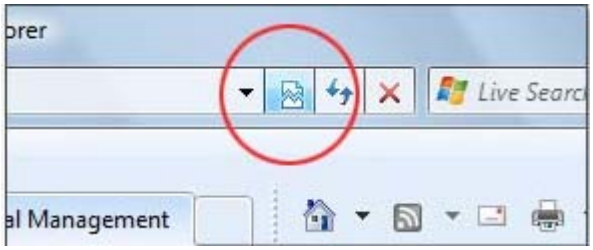
- The supported languages are:
  - English (Default)
  - Chinese
  - Czech
  - German
  - French
  - Russian
  - Spanish

  (For other languages – please contact your local Elspec distributor)

- The Password field defines user level/privileges. The user levels are **Viewer / Administrator (**See Security Settings**).** The default password including privileges for each level are:
    - Viewer is **123** (Read only, can choose interface language only, no operations related changes are allowed)
    - Administrator is **12345** (Administration, setup & full control)

NOTE NOTE NOTE

- The Website is optimized to work with Internet Explorer 7, 8 or 9 in "Compatibility View". Ensure that the Internet Explorer is running in **Compatibility View:**

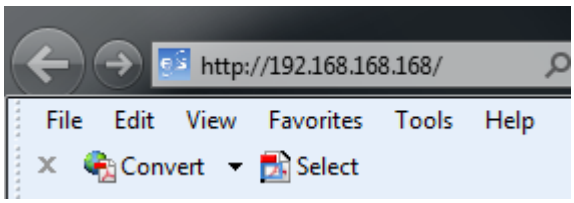


Other web browser applications can limit some functionality and/or show an incorrect layout.

- For local networking the browser should be configured as working without a proxy server. Refer to Disable Proxy Server in Internet Explorer.
- Should you be running Skype simultaneously with Elspec's Search, you will not be able to access the device via the Web Link. Close Skype & access Elspec's Search again to follow the Web Link.
- The passwords above are factory default values. You are advised to modify Admin password if extended security measures are required **(**See Security Settings).

DIRECT INSTRUMENT ACCESS VIA INTERNET EXPLORER:

Access the device by typing the BLACKBOX's IP address in the address field in Internet Explorer:



- Choose the language & enter the password as outlined above

SEE ALSO:

- About Quick Installation
- Unit Powering
- About Portable Wiring
- Plug and Play Voltage & Current Probes
- Grounding
- Establish 1st Time Connection
- About Quick Configuration
- Verify Measurement Readings
- Enable PQZIP Recording

About Quick Unit Configuration

This section focuses only on the major configurations needed for initial installation of your Portable BLACKBOX device. Configurations are done via Elspec's Web Interface. For a more detailed & comprehensive procedure see Instrument Settings. This procedure includes a quick & simple configuration procedure for your:

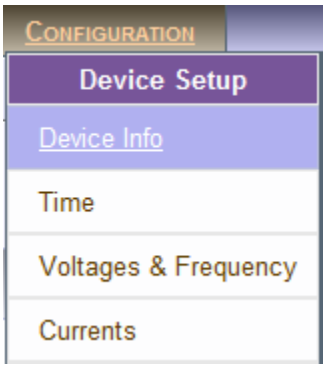
- Portable BLACKBOX Unit
- Voltage & Frequency
- Currents

SEE ALSO:

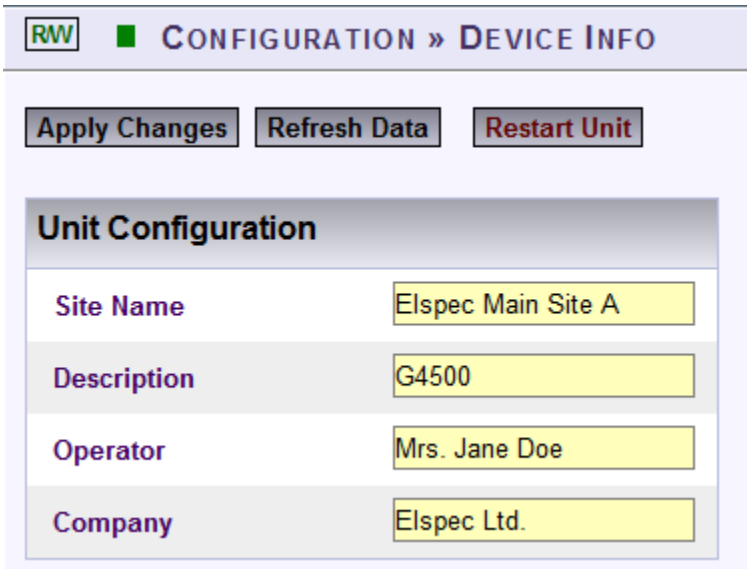
- About Quick Installation
- Unit Powering
- About Portable Wiring
- Plug and Play Voltage & Current Probes
- Grounding
- Establish 1st Time Connection
- Unit Access
- Verify Measurement Readings
- Enable PQZIP Recording

Quick Unit Configuration

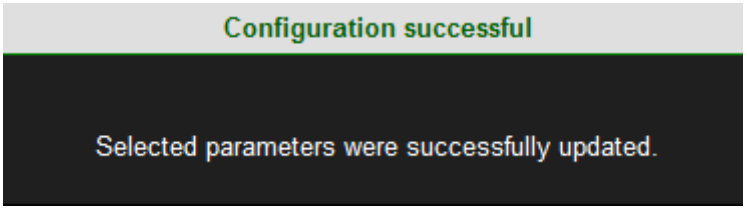
- After you have Plugged in your Device, you will need to configure the unit itself. Access your Portable Device via **Elspec's Web Interface** ➡ log on as the **Administrator** ➡ under **Configuration** ➡ **Device Setup** select the **Device Info Tab:**



- In the **G4 Unit Configuration** Section complete:
  - **Site Name:** Enables the user to define a description of the site where the device is installed. This site description also appears in the Elspec's Search utility under Unit Description when searching for devices
  - **Description:** An additional text field for you to use optionally as you see fit
  - **Operator:** A text field typically for inputting operator/technician name
  - **Company**: A text field typically for inputting company name



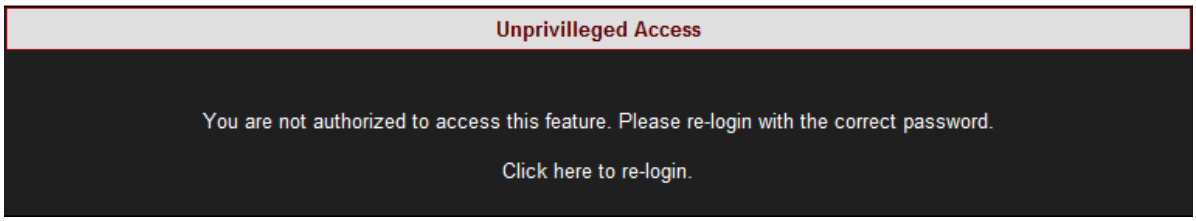
- To apply your changes select Apply Changes. A success message will confirm your changes:



- To review your changes select Refresh Data
- Go to the next step Configuring Voltage & Frequency

NOTE NOTE NOTE

If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:


Unprivilleged Access
You are not authorized to access this feature. Please re-login with the correct password.
Click here to re-login.

Once you have signed on at the Administrator ensure that you select Apply Changes to actually affect your changes.

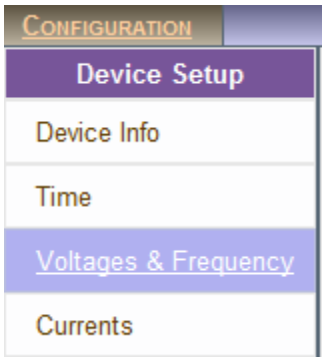
SEE ALSO:

- About Quick Configuration
- Voltage & Frequency
- Currents

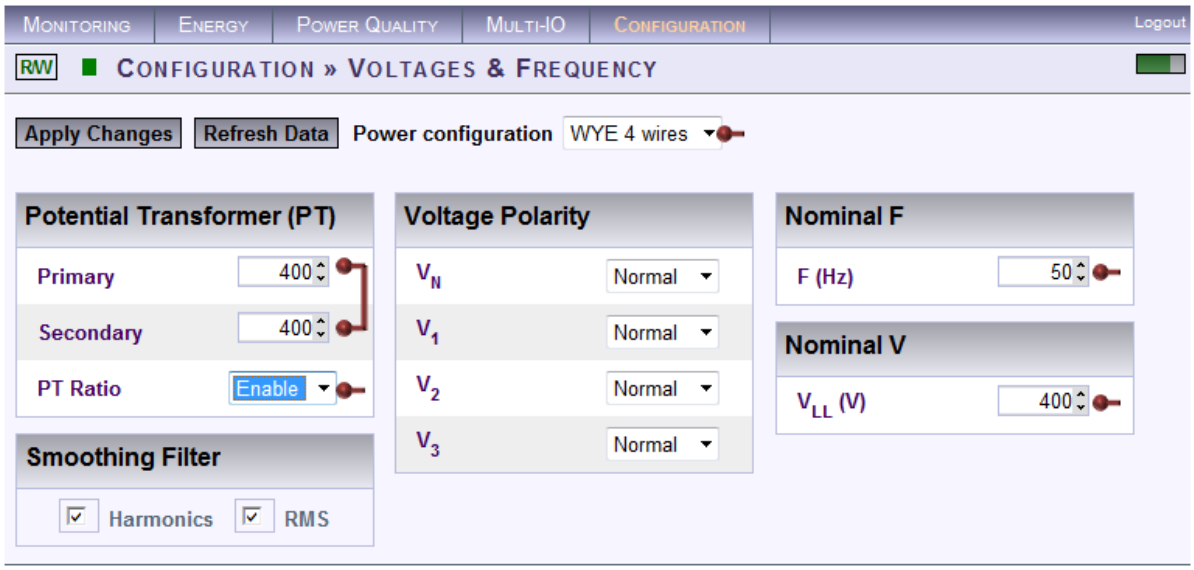
Voltage & Frequency Configurations

As mentioned previously, after you have Plugged in the Voltage Probes it will be automatically recognized. Therefore, only minor configuration adjustments will need to be made in the **Voltage & Frequency Configuration Window.**

- Access your Portable BLACKBOX Unit via **Elspec's Web Interface** ➡ log on as the **Administrator** ➡ under **Configuration** ➡ **Device Setup** select the **Voltage & Frequency Tab:**

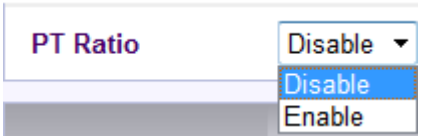


- In the **Voltage & Frequency Window:**

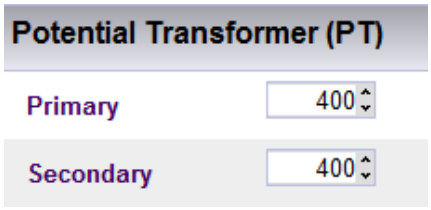


  - Select the applicable **Network Type Settings** according to your Network Type from the drop-down selection:

  - If you wish to measure the Potential Transformer (MV/HV Networks - Voltage Measurements by PT's) select **Enable:**



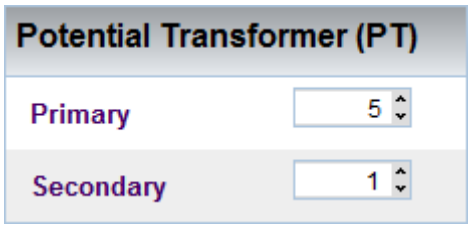
- For MV/HV Networks (Voltage Measurements by PT's) set the correct **Primary & Secondary Ratio** (with /) – according to the **PT Manufacturer's Specifications** & not just the **Ratio**:



- Define the **Nominal Values** for Frequency (F) and Voltages (V) (with ▲/▼):

- The ratio for LV Networks (<1kV) is based on the same concept & specifications:

Set the **Primary & Secondary Ratio** (with /) –(according to the **PT Manufacturer's Specifications** & not just the **Ratio)**:

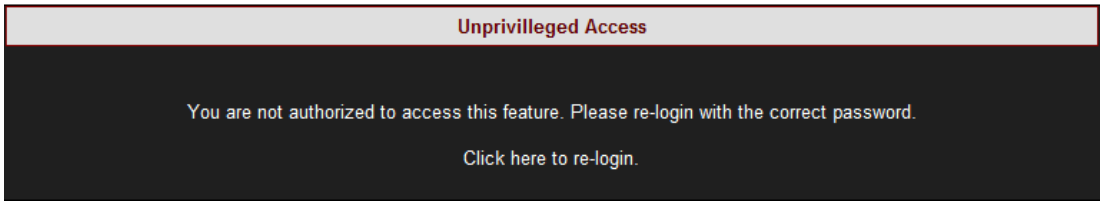


Define the **Nominal Values** for Frequency (F) and Voltages (V) (with /):

- To apply your changes select Apply Changes ➡ Refresh Data to review your changes
- Go to the next step Current Configuration

NOTE NOTE NOTE

If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:


Unprivilleged Access
You are not authorized to access this feature. Please re-login with the correct password.
Click here to re-login.

Once you have signed on at the Administrator ensure that you select Apply Changes to actually affect your changes.

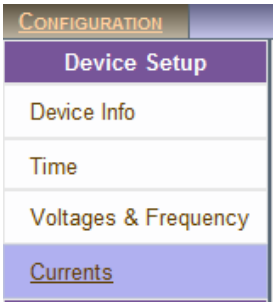
SEE ALSO:

- About Quick Configuration
- Unit Configuration
- Currents

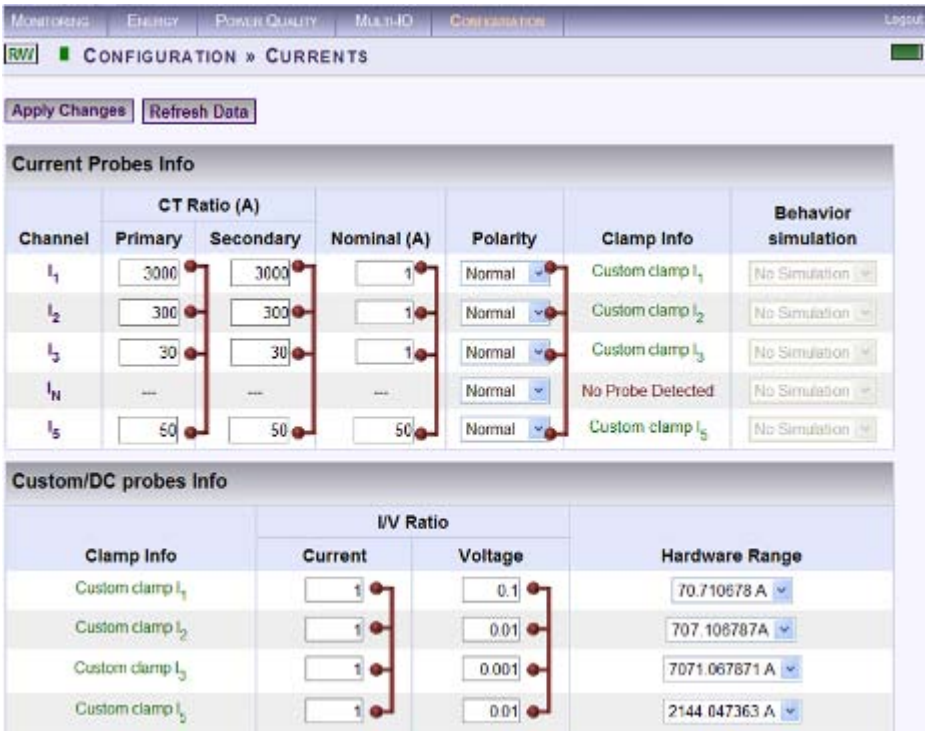
Currents

As mentioned previously, after you have Plugged in your Current Probes it will be automatically recognized. Therefore, only minor configuration adjustments will need to be made in the **Current Configuration Window.**

- Access your Portable BLACKBOX Unit via **Elspec's Web Interface** ➡ log on as the **Administrator** ➡ under **Configuration** ➡ **Device Setup** select the **Currents Tab:**



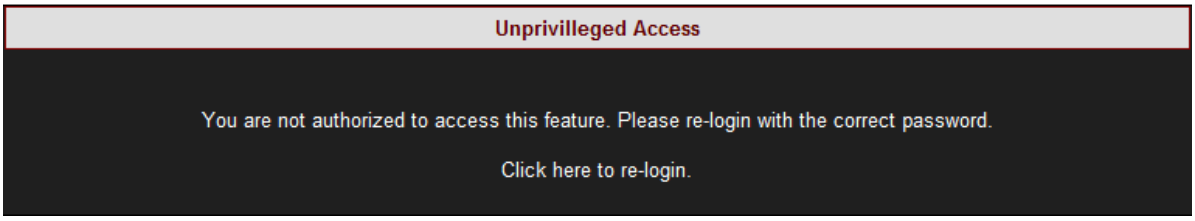
- In the **Currents Window** adjust**:**
  - **Primary & Secondary Transformation Ratios** for all the Current channels,
  - **Nominal Ampere Values** for all the Current Channels (Nominal is set for the current measurements that will define PQZIP threshold / tolerance value & it is also used for event settings)
  - Either **Reverse** the **Polarity** / maintain it at **Normal** from the drop-down selection (Polarity toggling is used to correct incorrect wiring)
  - Clamp's **Current / Voltage Ratio** (As per Clamp's individual Specifications) &
  - **Hardware Range** (As per Clamp's individual Specifications):



- To apply your changes select Apply Changes → Refresh Data to review your changes

NOTE NOTE NOTE

If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:


Unprivilleged Access
You are not authorized to access this feature. Please re-login with the correct password.
Click here to re-login.

Once you have signed on at the Administrator ensure that you select Apply Changes to actually affect your changes.

SEE ALSO:

- About Quick Configuration
- Unit Configuration
- Voltage & Frequency

About Verifying Measurement Readings

The final step after you have Configured your Device, is to verify the voltage & current measurements of your Portable BLACKBOX. This verification step covers only a partial section of the BLACKBOX's Full PQ Monitoring Capabilities. It includes:

- Accessing & Reviewing the Measurement Summary
- Accessing & Reviewing Voltage & Current Measurements
- Accessing & Reviewing the Power

SEE ALSO:

- Quick Installation
- Unit Powering
- Establish 1st Time Connection
- Plug & Play - Voltage & Current Probes
- Unit Access
- Quick Unit Configuration
- Enable PQZIP Recording

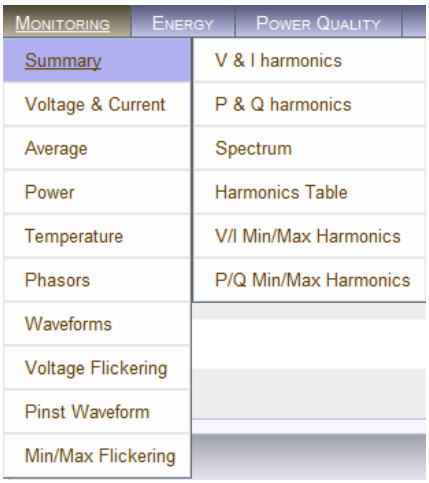
Access the Measurement Summary

The Measurement Summary summarizes all your measurement readings. The most important parameters you will need to focus on in this window are **Phase Order (for 3 phase systems)** & **DSP Synchronization:**

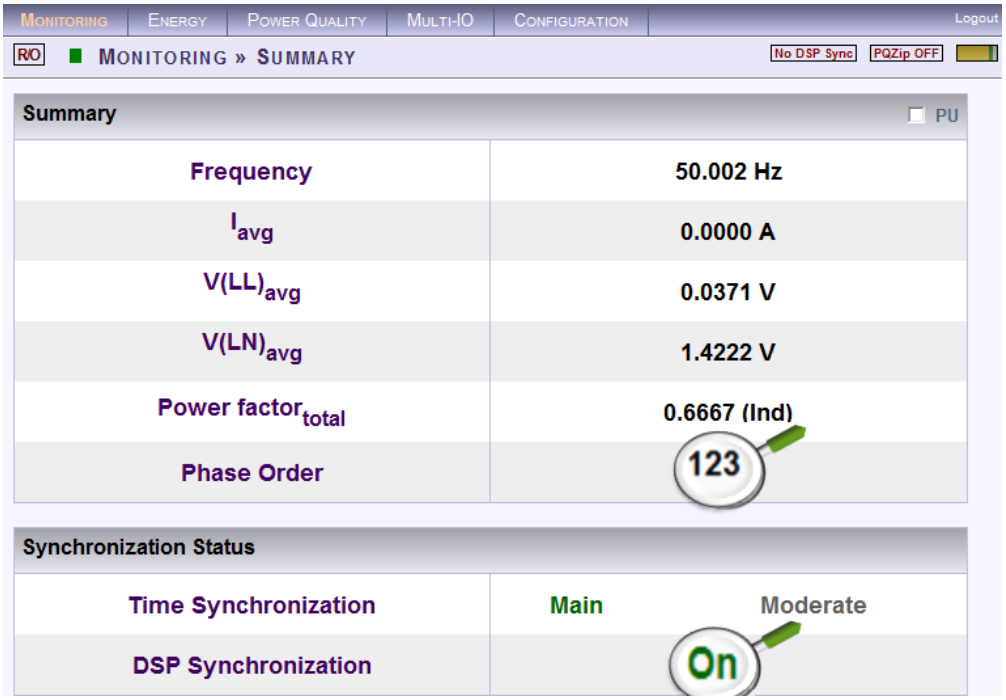
- **Phase Order:** Confirms the order of the voltage phases starts from V_1 & are moving in a clockwise direction
- **DSP Synchronization:** Confirms that the unit is synchronized with the network
- For a full description on all the definitions & subsequent parameter calculations see PQ Monitoring

ACCESS THE SUMMARY WINDOW

- Access your Portable BLACKBOX Unit via the Web Interface ➡ Open **Monitoring ➡ Summary:**



- The **Summary Window** will now open:



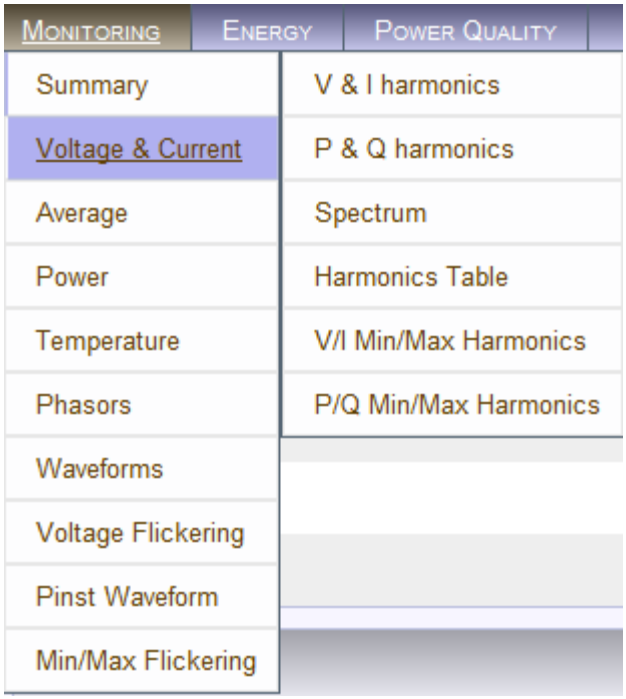
SEE ALSO:

- About Measurement Readings
- Verify Voltage & Current
- Verify Power

Verify Voltage & Current Readings

This page displays specific values as per the parameters configured for Voltage & Current for your G4500/G3500 Unit. For a full description on all the definitions & subsequent parameter calculations see Voltage & Current.

- Access your Portable BLACKBOX Unit via the Web Interface ➡ Open **Monitoring ➡ Voltage & Current:**



- Verify that the **RMS** values are as expected for both **Voltage & Current** are as per your Configurations:

R/O ■ MONITORING » VOLTAGE & CURRENT

V/I PU

	RMS	Min Value	Max Value	THD	Crest Factor	K Factor
V_1	1.4231 V	1.3982 V	230.67 V	6.8858 %	1.9276	---
V_2	1.4215 V	1.3983 V	229.43 V	6.9813 %	1.5061	---
V_3	1.4277 V	1.4037 V	230.67 V	6.8337 %	1.9216	---
V_N	0.2064 V	0.1398 V	0.2833 V	----	----	---
V_{12}	0.0451 V	0.0382 V	1.2344 V	----	----	---
V_{23}	0.0449 V	0.0379 V	1.2347 V	----	----	---
V_{31}	0.0224 V	0.0117 V	0.0249 V	----	----	---
I_1	0.0000 A	0.0000 A	49.982 A	----	----	----
I_2	0.0000 A	0.0000 A	1.6611 kA	----	----	----
I_3	0.0000 A	0.0000 A	46.349 kA	----	----	----
I_N	0.0789 A	0.0000 A	21.106 A	6.0762 %	35.674	1.2583
I_5	0.0794 A	0.0000 A	75.190 A	5.8634 %	35.563	1.0700

- Should the values be incorrect, recheck the PT/CT Ratios as well as the power source, Voltage & Current Probe Connections.

- Go to the next step - Verifying your Power in order to verify that the **Active Power** readings are based on your Current Configurations

SEE ALSO:

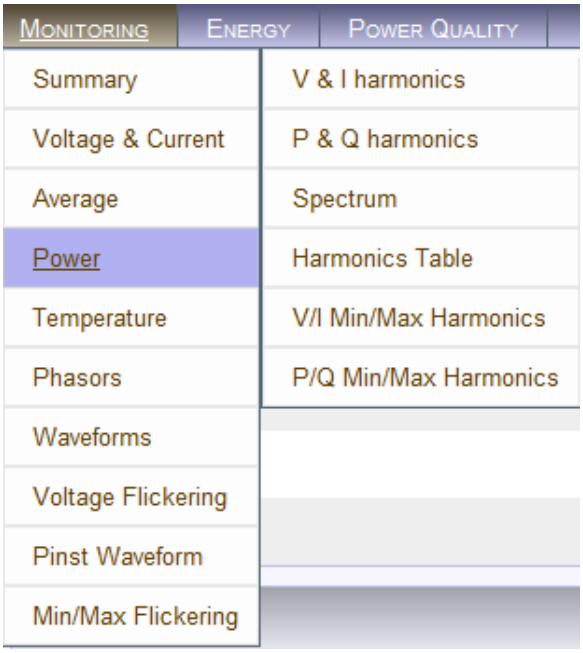
- About Measurement Readings
- Access Measurement Summary
- Verify Power

Verify Power Readings

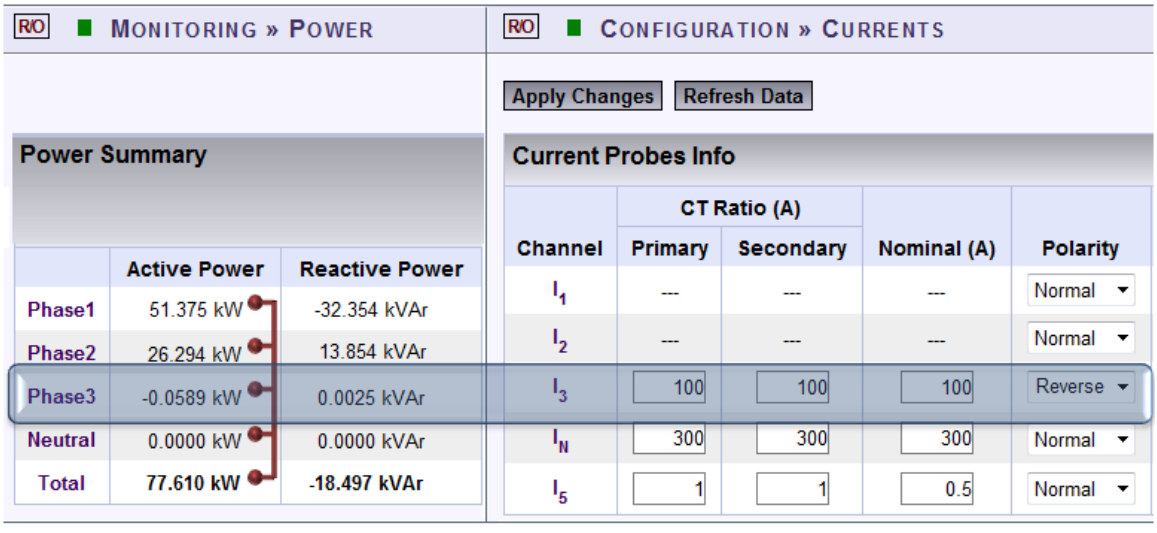
Although Power Configurations is comprehensively dealt with in the Power Section, this section is necessary to verify that all the **Active Power** readings reflect **Positive Values**. Corrections can be made by toggling the polarity in the Current Configurations.

For a full description on all the configurations, definitions & subsequent parameter calculations see Power.

- Access your Portable BLACKBOX Unit via the Web Interface ➡ Open **Monitoring ➡ Power:**



- Verify that the **Active Power** readings reflect **Positive Values**:



- Should any of the **Phase Integers** display a negative value (as per the highlighted section above) you will need to **Reverse** the **Polarity** for the **Phase** in the Current Configurations. Alternatively you may also physically reverse the current clamp at the power source, by changing the direction. Generators commonly display a negative Active Power value.

SEE ALSO:

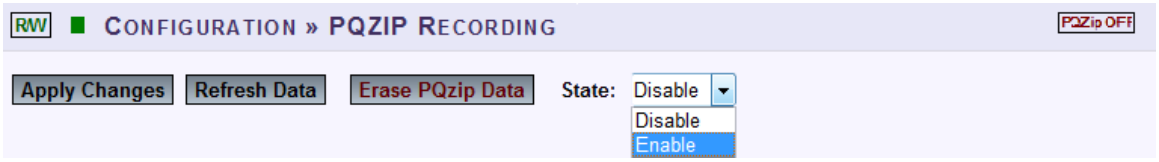
- About Measurement Readings
- Access Measurement Summary
- Verify Voltage & Current

Enabling PQZIP Recording

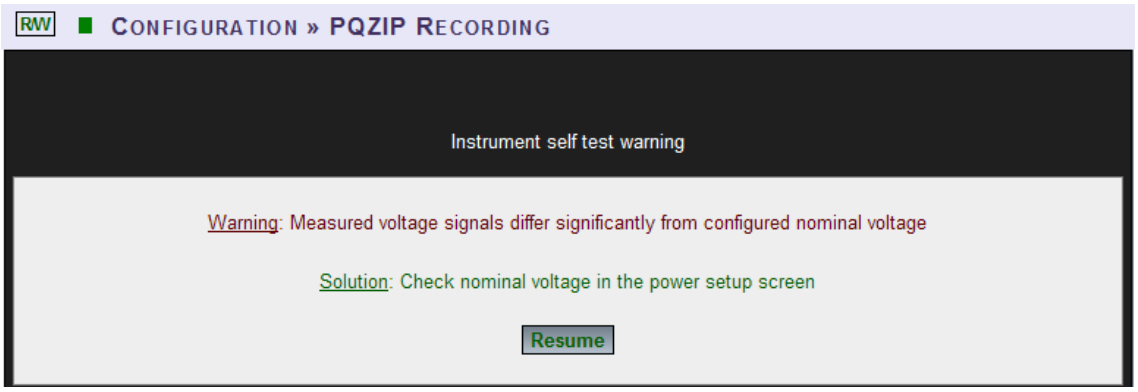
In order to record actual data for further analysis by PQSCADA & Investigator, you must first enable the PQZIP Recording.

HOW TO ENABLE PQZIP RECORDING

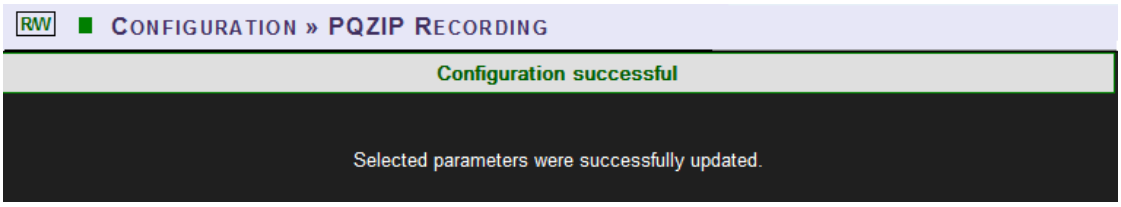
- Access your Portable BLACKBOX Unit via the Web Interface ➡ Open **Configuration** ➡ **PQZIP Recording**
- In the **State** drop-down selection select **Enable:**



- To apply your changes select **Apply Changes**
- The following warning may appear if some parameter readings are inconsistent with the configuration. In this case make sure all parameters are correct before enabling the PQZIP:


RW
CONFIGURATION » PQZIP RECORDING
Instrument self test warning
Warning: Measured voltage signals differ significantly from configured nominal voltage
Solution: Check nominal voltage in the power setup screen
Resume

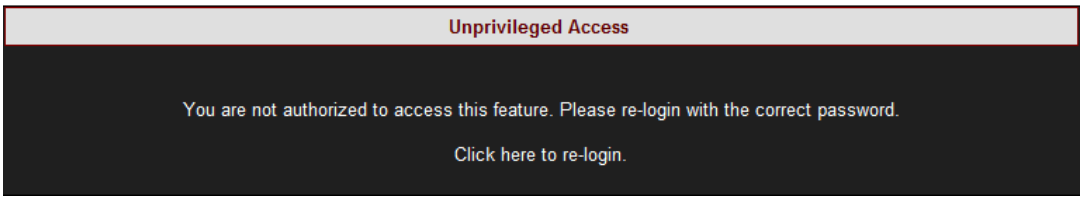
- Confirm by selecting **Resume** & the following success message will appear:



- To view your changes (refresh your current view) select **Refresh Data**

NOTE NOTE NOTE

- If you are not logged on as the Administrator, you will not be able to change any of these settings & you will receive the following error message in your attempt to do so:


Unprivileged Access
You are not authorized to access this feature. Please re-login with the correct password.
Click here to re-login.

- Once you have signed on at the Administrator ensure that you select Apply Changes to actually affect your changes.
- Once you have enabled the PQZIP recording, the PQZIP OFF Icon will no longer appear on the right-hand side on this & any other screen:

SEE ALSO:

- About Quick Installation
- Unit Powering
- About Portable Wiring
- Plug and Play Voltage & Current Probes
- Grounding
- Establish 1st Time Connection
- Unit Access
- About Quick Configuration
- Verify Measurement Readings

Battery Replacement

The BLACKBOX Portable is equipped with an internal lithium battery that will allow you to operate the BLACKBOX for up to 2 hours without having to connect to either an AC/DC external power source. The battery requires no maintenance whatsoever & is designed for a long-life service. However, should the battery's performance decrease significantly, it will need to be replaced with an original component that can be either ordered directly from Elspec or, from your local Elspec Agent. Before you start, ensure that you Take the Necessary Safety Precautions & Ensure Your Have All the Tools You Will Need for Changing the Battery.

VERIFY THE BATTERY'S OPERATION VIA POWER SUPPLY INDICATORS:

Flashing Blue	**Main Auxiliary Power Applied, Battery Charging**	
Solid Blue	**Main Auxiliary Power Applied, Battery Fully Charged**	

In this section you will be able to:

- Remove the Malfunctioned Battery
- Install the New Battery & Verify Operation

Remove The Malfunctioned Battery

Ensure you Have all You Need & have taken the necessary Safety Precautions.

▪ Remove the **Rubber Cover** from the Front Panel:	
▪ Remove all screws from the Front Panel (6 x Flat & 2 x Phillips Screws):	
▪ Remove the Front Panel with the **Bracket** at a straight angle (as not to damage the antenna):	
▪ Remove the **Battery Connector** from the device terminal located on the front:	
▪ Remove the **Battery** from the **Battery Housing**:	

Proceed to the **Next Step - Battery Replacement**

SEE ALSO:

- About Battery Replacement
- Safety Precautions
- What You'll Need
- G3500 BLACKBOX Unit
- G4500 BLACKBOX Unit

Replace The New Battery

After you have Removed the Malfunctioned Battery, you can now proceed to replace it:

▪ Place the **New Battery** in the **Battery Housing**:	
▪ Reconnect the **Plug Connector** from the battery to the **Terminal Inside the Device**. Ensure that the wires are properly tucked into the housing:	
▪ Replace the Front Panel & re-secure the screws. ▪ Replace the **Rubber Cover**. ▪ Re-connect all the Power & Communication Cables.	
▪ On the Front Panel turn on the Main Power Supply Switch to the **ON** position:	

VERIFY OPERATION VIA INDICATORS		
Flashing Blue	**Main Auxiliary Power Applied, Battery Charging**	
Solid Blue	**Main Auxiliary Power Applied, Battery Fully Charged**	
Red	**No main or auxiliary power available/Powered by internal battery**	

SEE ALSO:

- About Battery Replacement
- Safety Precautions
- What You'll Need
- G3500 BLACKBOX Unit
- G4500 BLACKBOX Unit

Specifications

This section includes common specifications for the Portable BLACKBOX:

INPUT CHARACTERISTICS:

VOLTAGE INPUTS	G4500	G3500
Number of Inputs	AC: 4 (3 Phases & Neutral) DC: 1	AC: 4 (3 Phases & Neutral)
Maximum Input Voltage (V_{RMS})	1KV	1KV
Nominal Voltage Range (V_{RMS})	110 to 690V	110 to 690V
Maximum Peak Measurement Voltage (V_{Pk})	8KV	8KV
Input Impedance	3MΩ	3MΩ
Bandwidth	25kHz	12.5kHz
Nominal Frequency	42.5 to 69Hz	42.5 to 69Hz
CURRENT INPUTS	**G4500**	**G3500**
Number of Inputs	AC: 4 (3 Phases & Neutral) DC: 1	AC: 4 (3 Phases & Neutral)
Maximum Peak Measurement (V_{Pk})	I1 to I4: 10; I5: 3 From Clamp	I1 to I4: 10; I5: 3 From Clamp
Type	Clamp On Current Transformer With mV Output	Clamp On Current Transformer With mV Output
Range (V_{Pk})	I1 to I4: 0 to 10; I5: 0 to 3 From Clamp	I1 to I4: 0 to 10; I5: 0 to 3 From Clamp
Bandwidth	6.25/12.5kHz	12.5kHz
SAMPLING SYSTEM	**G4500**	**G3500**
Maximum Sampling Rate for Each Channel Simultaneously:		
Voltage	1024 Samples/Cycle	512 Samples/Cycle
Current	256 Samples/Cycle	512 Samples/Cycle
VDC	1 Sample/Second	N/A
Type of Analog to Digital Converter	16/20 [1] Bit	
Resolution	Dual Range Gain of 2 x 16 Bit On 8 channels	
PLL Synchronization	1024 Samples On 10/12 Cycles According IEC61000-4-7	

[1] Effective Bit

MEASUREMENT RANGE, RESOLUTION, ACCURACY:

VOLT/AMPS/HERTZ	MEASUREMENT RANGE	RESOLUTION	ACCURACY
V_{RMS} (AC & DC)	0 to 900V	0.01V	±0.1% of Nominal Voltage[1]
A_{RMS}			
With SOA-9045-3001	90A to 15kA	0.1mA	±0.5% ±0.5A of Nominal Current[2]
With SOA-9091-3000	9 to 1.5kA	0.1mA	±0.8% ±0.1Aof Nominal Current[2]
With SOA-0010-0500	0.02 to 6A	0.1mA	±0.15% ±0.5mAof Nominal Current[2]
V_{Pk}	8KV	10mV	±0.1% from Reading
Voltage Crest Factor	1<	0.01	Better than 0.5%
Current Crest Factor	1<	0.01	Better than 0.5%
Hz @ 50Hz Nominal	42.5 to 62Hz	10mHz	±5mHz
Hz @ 60Hz Nominal	51 to 69Hz	10mHz	±5mHz
K-Factor	0<	0.01	±0.25%
DIPS, SWELLS & INTERRUPTIONS	**MEASUREMENT RANGE**	**RESOLUTION**	**ACCURACY**
V_{RMS}½ (AC & DC)	0 to 900V	0.01V	±0.2% of Nominal Voltage
Duration	HHH,MM,SS,MMM	Half Cycle	One Cycle
Threshold Levels	Programmable Thresholds & Hysteresis in Percentage of Nominal Voltage Event Detection Based Upon ½ Cycle RMS Voltages Captures Dips, Swells, Interruptions & Rapid Voltage Changes		
VOLTAGE HARMONICS	**MEASUREMENT RANGE**	**RESOLUTION**	**ACCURACY**
Harmonic Order	1 to 50 Grouping: Harmonic Subgroups According to IEC61000-4-7		
Inter-Harmonic Order	1 to 50 Grouping: Inter-Harmonic Subgroups According to IEC61000-4-7		
THD $_{(n=50)}$	0 to 100%	0.01%	±0.25%
THD Even	0 to 100%	0. 01%	±0.25%
THD Odd	0 to 100%	0.01%	±0.25%
Hz (Spectrum)	0 to 3174Hz	fSys 10/12	±5%
Phase Angle	-180 to +180º	0.01º	±0.01º

[1] For Nominal Voltage 80 to 690V

[2] Depending on the Clamp Accuracy

MEASUREMENT RANGE, RESOLUTION, ACCURACY:

POWER & ENERGY	MEASUREMENT RANGE	RESOLUTION	ACCURACY
Active Power	Depends on Clamp & PT Configuration	10mW	±0.2%[1]
Reactive Power	Depends on Clamp & PT Configuration	10mVAR	±2%[1]
Apparent Power	Depends on Clamp & PT Configuration	10mVA	±0.2%[1]
Active Energy	Depends on Clamp & PT Configuration	10mWh	±0.2%[1]
Reactive Energy	Depends on Clamp & PT Configuration	10mVArh	%[1]
Apparent Energy	Depends on Clamp & PT Configuration	10mVAh	±0.2%[1]
True Power Factor	±1 (CAP\IND)	10µ	±0.2%[1]
Displacement Power Factor	±1 (CAP\IND)	10µ	±0.2%[1]
FLICKERING	**MEASUREMENT RANGE**	**RESOLUTION**	**ACCURACY**
P_{SST}, P_{ST} 10 Minutes, S_{PLT}, P_{LT} 2 Hours, L_{PLT}	0 to 20	0.01	±5%
PST_{INST}	0 to 20	0.01	±8%
UNBALANCE	**MEASUREMENT RANGE**	**RESOLUTION**	**ACCURACY**
Volts (Negative & Zero Seq.) Ratio	0 to 100%	0.1%	0.15%
Current (Negative & Zero Seq.) Ratio	0 to 100%	0.1%	0.5%[1]
TRANSIENT CAPTURE			**ACCURACY**
Minimum Detection Duration			39 µs (G3500) 19.5 µs (G4500)

[1] Depending on the Clamp Accuracy

GENERAL SPECIFICATIONS:

STORAGE CAPACITY	G4500	G3500
Internal Memory	32GB	256MB
STORAGE CAPACITY		
Real Time Clock	± 1 Second per 24 Hours	
Time Synchronization	Optional GPS/SNTP/IRIGB/DCF-77 time sync module provides time uncertainty better than 100µs. When synchronization becomes unavailable, Time Tolerance is 1 second per day.	
DEVICE SYNCHRONIZATION ACCURACY		
GPS & PPS	Better than 100µs	
IRIG B	100 to 200µs	
DCF-77	±15ms	
SNTP Server	50-100µs	
COMMUNICATION CONTROL		
Web Server	Comprehensive web server for local & remote real-time monitoring & control	
FTP Server	Standard protocol for main storage memory	
PORTS	**G4500**	**G3500**
Ethernet Ports	2 LAN & 1 USB (Integrated Router, NAT & Firewall)	1 LAN
RS-232	1	1
RS-485/422	1	1
Wi-Fi Communications (802.11g)	1 (With Integrated Antenna)	—
LAN 1		
Baud Rate	10/100 Mbit	
Communication Protocols	TELNET, OPC & SMTP Client	
Connector Type	RJ45 Female With Led Indicators	
Power Over Ethernet (PoE- In)	1 (Available as Input – 13 Watt, DC: 48V)	
LAN 2		
Baud Rate	10/100 Mbit	
Communication Protocols	TELNET, OPC, & SMTP Client	
Connector Type	RJ45 Female With Led Indicators	
Power Over Ethernet (PoE- Out)	1 (Available as Output - 13 Watt, DC: 48V)	

GENERAL SPECIFICATIONS:

RS485/422 CONNECTION	
Baud Rate	Configurable: 1200 / 2400 / 4800 / 9600 / 14400 / 19200 / 38400 57600 / 115200
Communication Protocols	PPP & TTY
Duplex	Full
Maximum Cable Length	15.2m (50')
RS232 CONNECTION (COM Compatible Interface)	
Default Configuration	Baud rate: 19200, Data Bits: 8 , Parity: None, Stop Bits: 1
Communication Protocols	GPS
Duplex	Full
Maximum Cable Length	15.2m (50')
APPLICABLE STANDARDS	
Measurement Standards	EN50160, IEEE1159, IEEE519, IEC61000-4-15, IEC61000-4-7, IEC61000-4-30 Class A
EMC Standards	EN61326, CFR47FCC, CISPR11 Group 1, FCC PART 15 Subpart B, EN61010-2, IEC61000-3-3, IEC61000-4-2, IEC61000-4-3, IEC61000-4-4, IEC61000-4-5, IEC61000-4-6, IEC61000-4-11
Environmental Standards	IEC60068-2-1, 2, 6, 27, 30, 75
Safety Standards	EN61010-1:2001 2ND Edition
POWER SUPPLY	
Power Over Ethernet (PoE- In) [1]	According to 802.3af
Operating Range	AC: 80 to 260V @ 50/60Hz DC: 110 to 300V
Auxiliary AC Supply	DC: 48V
Battery Backup	2 Hours

[1] G4500 Unit Only

PQZIP RECORDING:

METHOD		
PQZIP compression technology which enables continuous gap-less[1] recording of all electrical parameters-related data for a significant time duration without the need of event thresholds of any kind. Events, Flicker and Energy are non-compressed parameters.		
WAVEFORM	**G4500**	**G3500**
Voltage Sampling per Cycle	1024/512	512
Current Sampling per Cycle	256/512	512
Recording Time	1 + Year Continuous Recording at a Fixed Ratio Mode of 2.5GB/Month	1 Week Continuous Recording at a Fixed Ratio Mode of 1GB/Month
EVENTS		
Memory	Up to 12K Event Logs	
FLICKER PST		
Recording Interval	10 Minutes	10 Minutes
Recording Time	1 + Year Continuous Recording at a Fixed Ratio Mode of 2.5GB/Month	1 Week Continuous Recording at a Fixed Ratio Mode of 1GB/Month
ENERGY		
Energy Interval	1, 2, 5, 10, 15, 30 & 60 Minutes	
Recording Time	1 + Year Continuous Recording at a Fixed Ratio Mode of 2.5GB/Month	1 Week Continuous Recording at a Fixed Ratio Mode of 1GB/Month

[1] 99.9% of the Time

IO PORTS:

DIGITAL INPUTS	
Channels	4
Sampling	800 Hz @ 50Hz (16 Samples per Cycle) 960 Hz @ 60Hz (16 Samples per Cycle)
Range	DC: 0 – 220V
Pulse Type	0->1->0, 1->0->1, KYZ
Isolation Connector	125V
RELAY OUTPUT	
Channels	1 x Change Over
Contact Configuration	1 CO (SPDT – Single Pole Double Throw)
Maximum Switching Voltage	AC: 277V
Maximum Current	AC: 5A/250V; 10A/110V DC: 5A/30V
Maximum Peak Current	15A
Rated Current	6A
Operating Time	4ms
Release Time	6ms
Maximum Reaction time	10ms
Maximum Drop-out time	4ms
Output Resistance	50MΩ

SEE ALSO:

- Physical

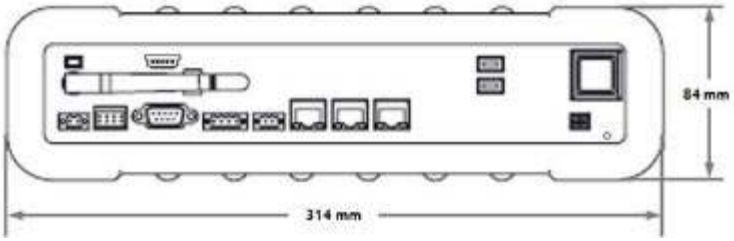
Physical Specifications & Dimensions of the Portable BLACKBOX

PHYSICAL SPECIFICATIONS

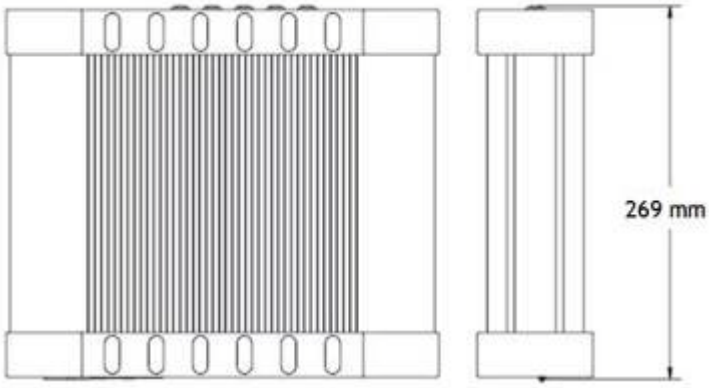
PHYSICAL	
Dimensions	314mm x 84mm x 269mm (12.36” x 3.3” x 10.59”)
Weight	3.7Kg (8.15Lb)
ENVIRONMENTAL	
Design	Rugged, Shock Proof with Integrated Protective Holster
Drip & Dust Proof	IP20 according to IEC60529 when used in tilt standard position
Shock & Vibration	Shock 30g, Vibration: 3g Sinusoid, Random 0.03 g2/Hz According to MIL-PRF-28800F Class 2
Operating Temperature	-0 to 40°C (32 to 104°F)
Storage Temperature	-20 to 60°C (-4 to 140°F)
Humidity	85%
Maximum Operating Altitude	2Km (1.24Mi)
Warranty	One Year
TEMPERATURE SENSORS	
External Temperature Sensor (PT100)	-40 to 90°C (-40 to 210°F)
Internal PSU Temperature Sensor	Informative
Internal DSP Temperature Sensor	Informative

DIMENSIONAL VIEW G4500:

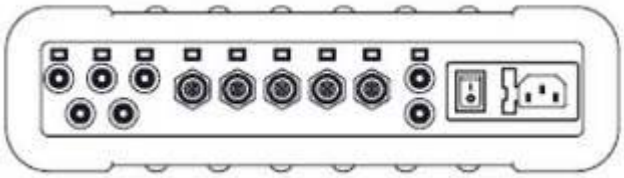
Front View



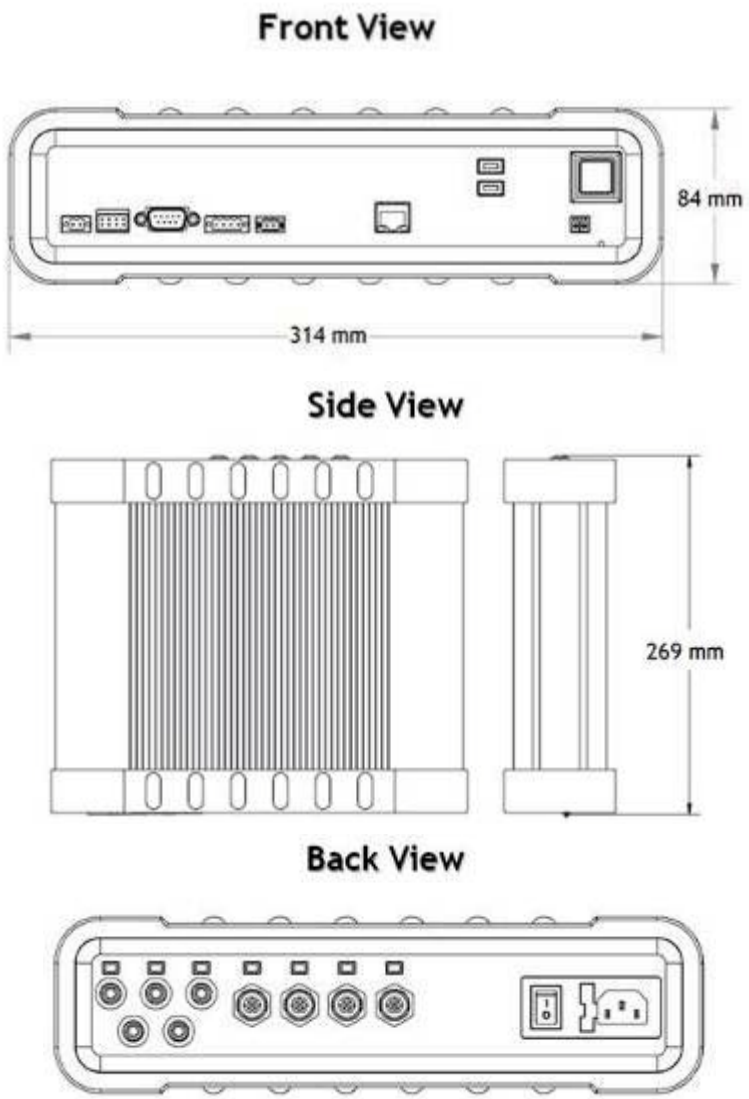
Side View



Back View



DIMENSIONAL VIEW G3500:



SEE ALSO:

- G4500 G3500 Specifications